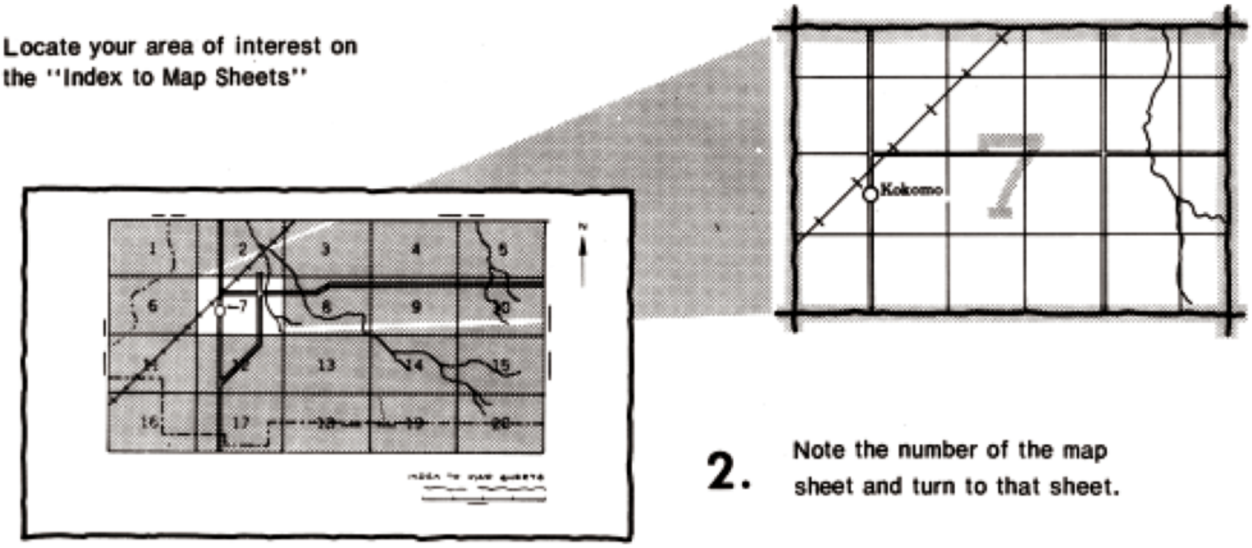
Soil survey of

Grand Forks County North Dakota

United States Department of Agriculture
Soil Conservation Service
in cooperation with
North Dakota Agricultural Experiment Station

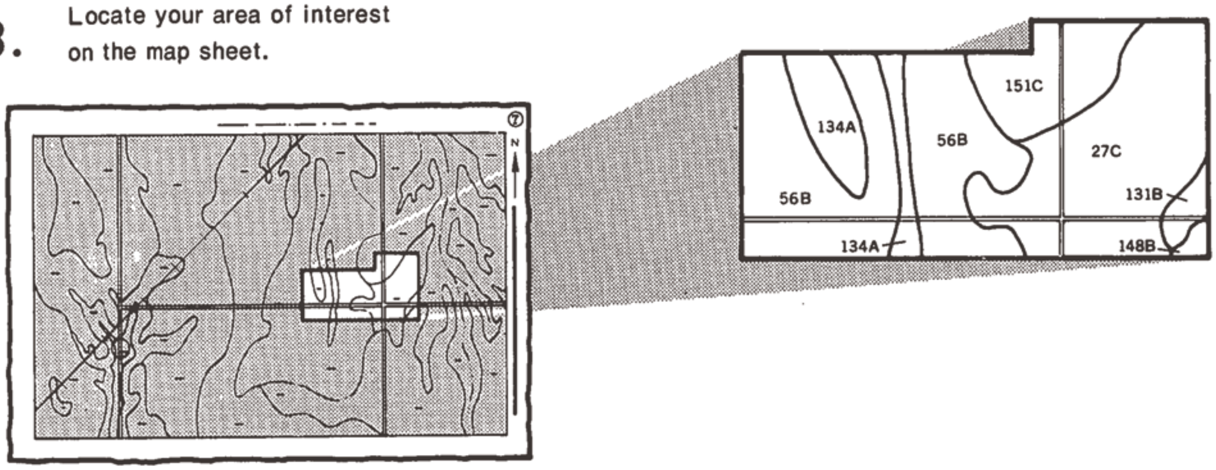
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"



2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



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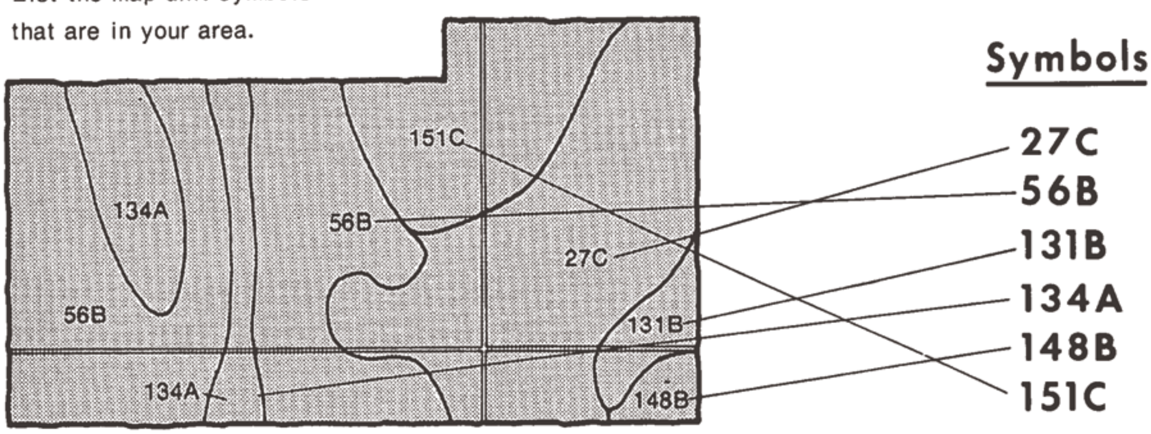
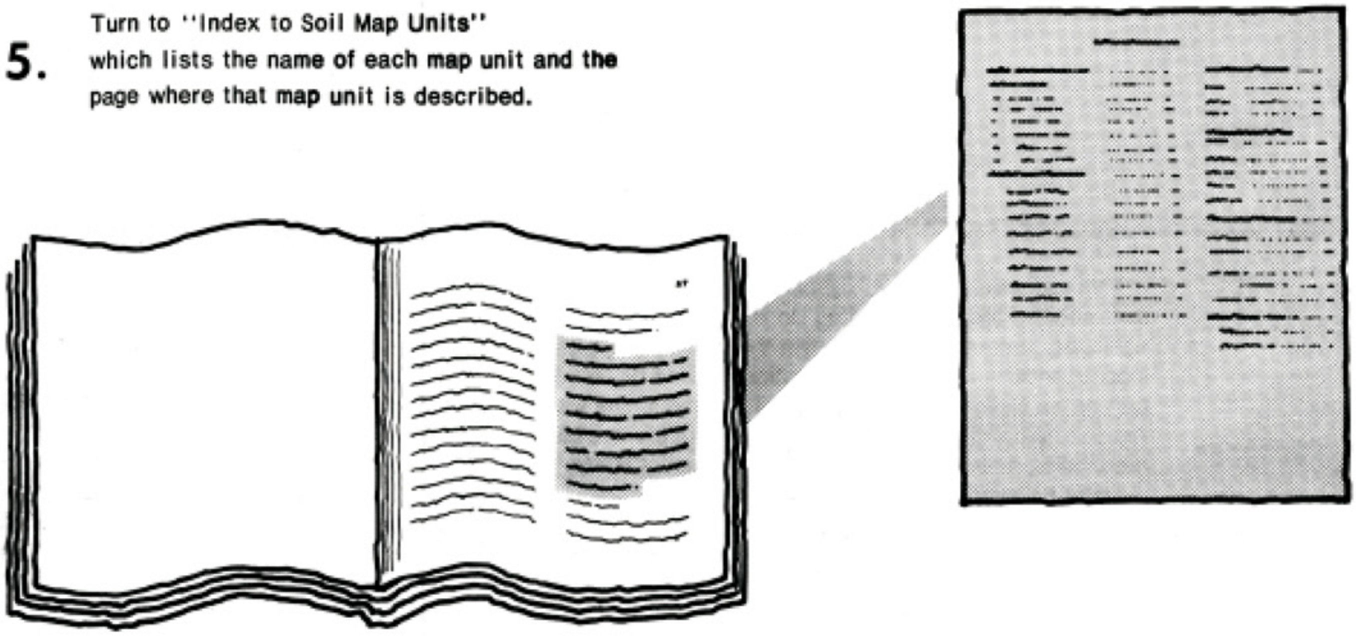
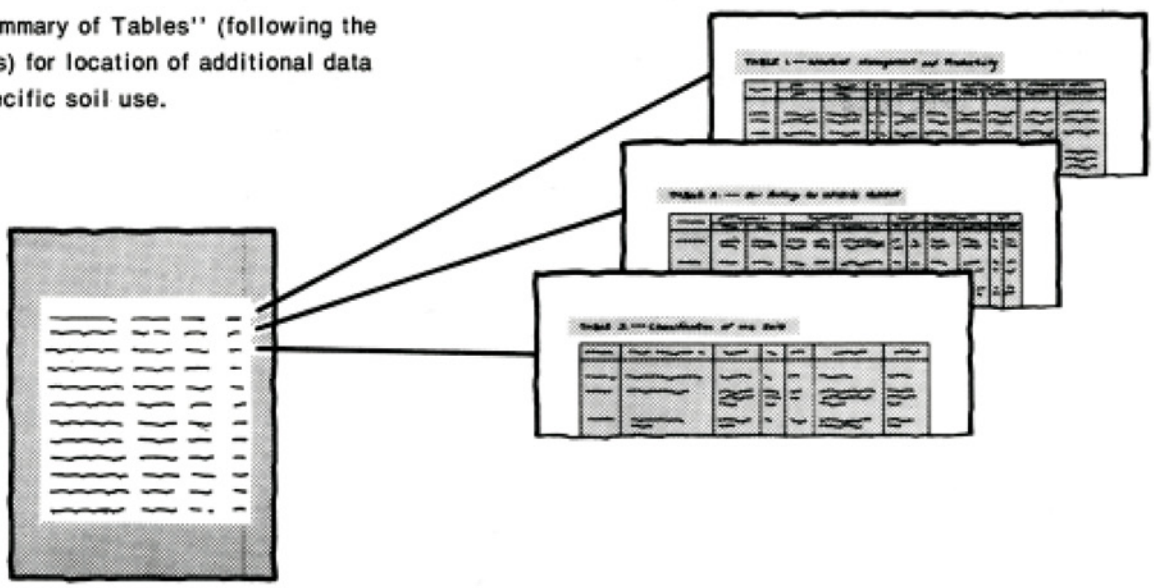


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Eastern and Western Grand Forks County Soil Conservation Districts. Financial assistance was provided by the Grand Forks County Board of Commissioners, the Old West Regional Commission, and the North Dakota State Soil Conservation Committee. Major fieldwork was performed in the period 1973-79. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Windbreaks on Glyndon silt loam, 0 to 3 percent slopes. The trees help to control soil blowing, protect farmsteads, provide wildlife habitat, and beautify the landscape.

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soil series

Issued May 1981

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foreword

This soil survey contains information that can be used in land-planning programs in Grand Forks County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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soil survey of
Grand Forks County, North Dakota

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United States Department of Agriculture, Soil Conservation Service,
in cooperation with the North Dakota Agricultural Experiment Station

GRAND FORKS COUNTY is in the northeastern part of North Dakota (fig. 1). It has an area of 920,320 acres, or 1,438 square miles. It is bordered on the east by the Red River of the North. Grand Forks, the county seat, is on the eastern boundary, about halfway between the northern and southern boundaries. In 1970, the population of the county was 61,102.

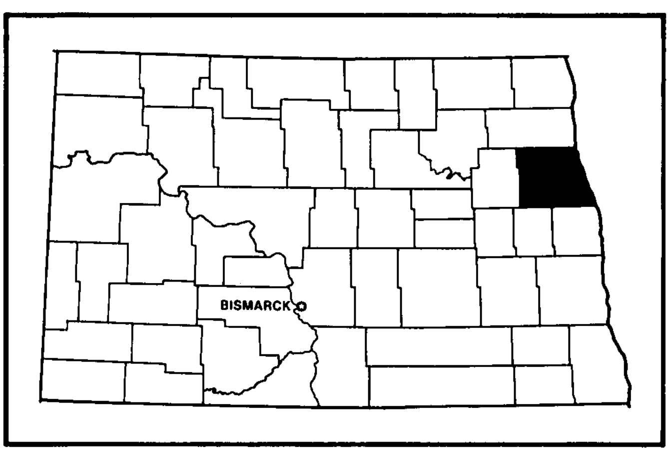

Figure 1.—Location of Grand Forks County in North Dakota.

Farming is the main economic enterprise. The principal crops are spring wheat, barley, sunflowers, potatoes, and sugar beets.

Most of the soils are deep. They are suited to cultivated crops and to pasture and hay. Unfavorable soil characteristics lower the potential of some soils for crops. Poor surface drainage in many level and depressional soils is the major concern of management, especially during wet periods. Soil blowing is a hazard on nearly all of the soils. It is most severe on the sandy soils on delta plains. On about 196,000 acres the soils are moderately saline to very strongly saline. The sandy and gravelly soils on beaches and delta plains have a very low to low available water capacity.

This survey updates the soil survey of the Grand Forks area published in 1902 (*7*). It provides additional information, surveys a larger area, and includes larger maps, which show the soils in greater detail.

general nature of the county

This section provides general information about the county. It describes climate; history and development; physiography, relief, and drainage; and water supply.

climate

Grand Forks County has a subhumid, continental climate. It is usually quite warm in summer, but frequent spells of hot weather and occasional cool days are typical. Temperatures are very cold in winter, when artic air frequently surges over the area. Most precipitation falls during the warm period and is normally heaviest late in spring and early in summer. Winter snowfall is normally not too heavy, and it is blown into drifts, so that much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Grand Forks, North Dakota, for the period 1951 to 1977. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 8 degrees F, and the average daily minimum temperature is -2 degrees. The lowest temperature on record, which occurred at Grand Forks on January 29, 1951, is -36 degrees. In summer the average temperature is 67 degrees, and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred on August 8, 1958, is 103 degrees.

Growing degree days, shown in table 1, are equivalent to heat units. During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 14 inches, or 76 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 3.85 inches at Grand Forks on August 30, 1951. Thunderstorms occur on about 30 days each year, and most occur in summer.

Average seasonal snowfall is 36 inches. The greatest snow depth at any one time during the period of record was 35 inches. On the average, 62 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The percentage of possible sunshine is 65 in summer and 50 in winter. The prevailing wind is from the north. Average windspeed is highest, 13 miles per hour, in spring.

Several times each winter storms with snow and high wind bring blizzard conditions to the area. Hail during summer thunderstorms occurs in scattered small areas.

Climatic data for this section were especially prepared for the Soil Conservation Service by the National Climatic Center, Asheville, North Carolina.

history and development

Prior to 1800, the junction of the Red River of the North and the Red Lake River of Minnesota was known as Les Grandes Fourches, or the Great Forks. The first explorers to venture into the county were Pierre Verendrye and his sons in the 1730's. The area became well known to trappers and fur traders working out of St. Paul, Minnesota, and Fort Garry, which is now known as Winnipeg, Manitoba. Trappers moved up and down the Red River of the North in canoes and overland on the two-wheeled "Red River Cart."

After the Civil War a mail route was established along the Red River of the North, between Fort Abercrombie and Pembina. In the fall of 1870, Alexander Griggs, a riverboat captain, and his crew were forced to stay over the winter at the fork of the Red River of the North and the Red Lake River. Captain Griggs later filed the first land plat of the original town. He is known as the "Founding Father of Grand Forks" (*5*). A post office was established and named Grand Forks.

Grand Forks County was part of Pembina County until 1873, when it was organized into a separate county. In 1874, it included all of what are now known as Traill and Steele Counties and parts of Griggs, Nelson, and Walsh Counties. In 1883, it was organized along its present boundaries.

After the Great Northern Railroad reached Grand Forks in 1881, the population of the county increased dramatically. It was slightly more than 6,000 in 1881 and more than 20,000 in 1885. The land was soon settled, and incoming pioneers had to move further west for available land.

The early pioneers settled along the Red River of the North and its tributaries, where the supply of freshwater and the supply of timber for the construction of buildings were ample. Some of the settlers who homesteaded away from the streams built their first houses and barns from thick sod stripped from their land.

From the time of the first settlement, farming has always been the main livelihood in the county. The first organized agriculture was started in 1875 and 1876. The wheat grown in these early years was hauled to Fargo by teams. The number of farms peaked around 1940 and has since steadily declined. In 1976, there were 1,279 farms. The average size of these farms was about 500 acres.

Grand Forks is the largest city in the county. According to a special 1976 census, it has a population of 42,599. It is a trade, medical, educational, cultural, and agribusiness center. The University of North Dakota,

which has an annual enrollment of more than 9,000, is on the western edge of the city. Other major towns are Larimore, Northwood, Emerado, Thompson, Gilby, Manvel, and Reynolds.

Three Federal highways and three state highways provide transportation and access to markets. Interstate Highway 29, U.S. Highway 81, and North Dakota Highways 18 and 32 are major north-south routes across the county. U.S. Highway 2 and North Dakota Highway 15 are the major east-west routes. These highways and the hard surfaced and gravelled county and township roads provide a good network of roadways. The county is also served by major air and rail lines.

physiography, relief, and drainage

Grand Forks County is in the Central Lowland Province (*4*). The eastern four-fifths of the county is in the Agassiz Lake Plain District and the western one-fifth in the Drift Plain District. These physiographic districts are separated by the subdued southern extension of the Pembina escarpment. The elevation of the Drift Plain District, or till plain, ranges from about 1,500 feet along the western margin of the county to 1,160 feet along the escarpment. The physiographic features of the Agassiz Lake Plain District are lake plains, beaches, areas between the beaches, and delta plains (fig. 2). The elevation of this district ranges from about 1,160 feet along the escarpment to about 800 feet in the northeast corner of the county. Glacial deposits mantle most of the county, but recent alluvium is deposited on the flood plains along streams.

The county is in the drainage basin of the Red River of the North. The major tributaries of this river are the Forest, Turtle, and Goose Rivers. The natural drainage pattern is most strongly expressed on the till plain, in

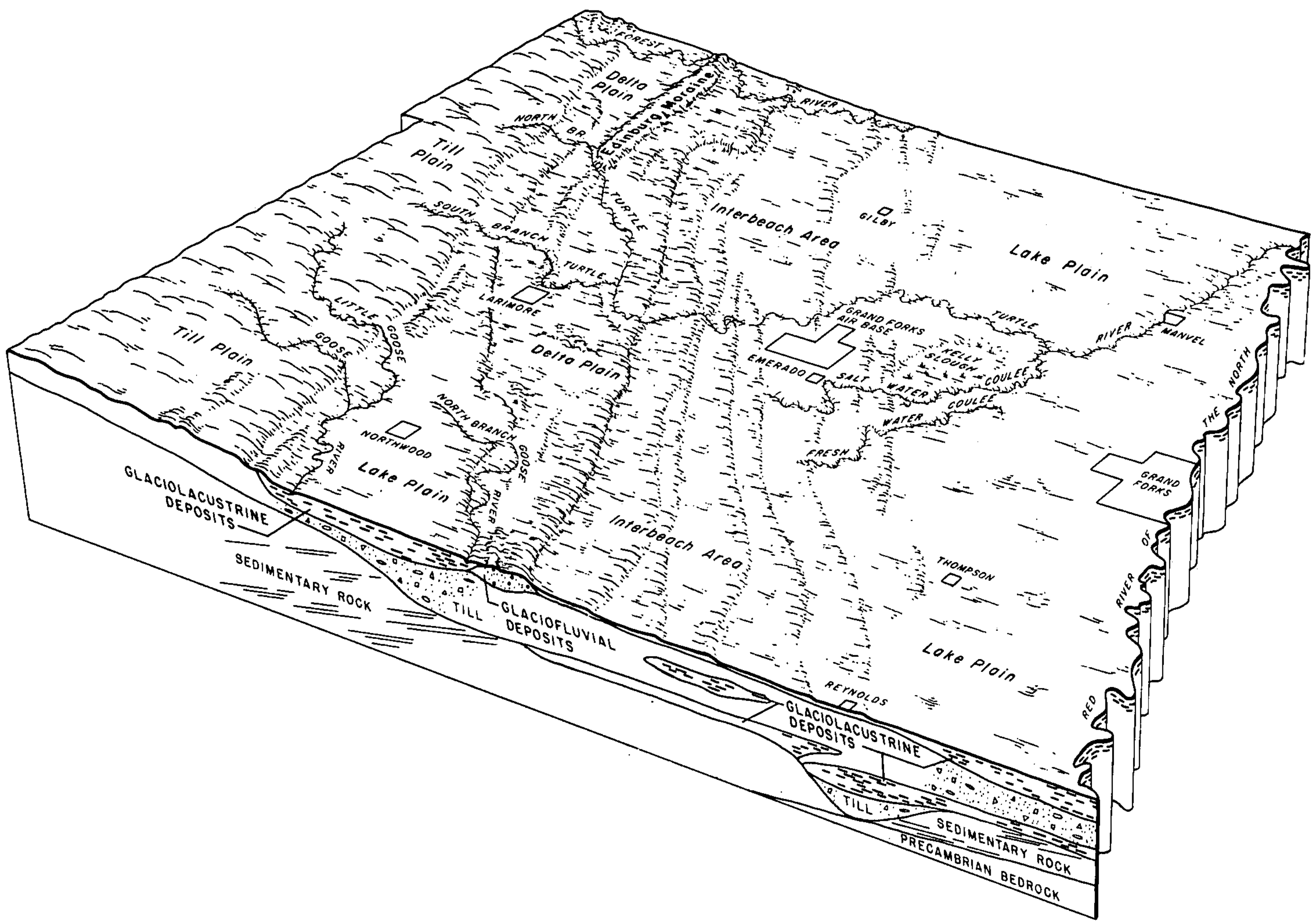

Figure 2.—Physiographic features of Grand Forks County, North Dakota.

areas that adjoin the Pembina escarpment. Except for the major streams that cross the area, the natural drainage pattern in the Agassiz Lake Plain District is poorly defined. It is characterized by many shallow depressions and swales. Excess water is removed from most areas by field drains, road ditches, natural runoff, or deep seepage.

The till plain consists of nearly level to gently rolling ground moraines and subdued end moraines that are locally accentuated by deep stream valleys and by isolated kames or eskers. It is characterized by small undrained depressions, which are more numerous along the western margin of the county. Local relief generally ranges from 10 to 40 feet, but in the deeper stream valleys it ranges from 25 to 100 feet. The Edinburg end moraine, a prominent narrow till ridge, is separated from the till plain by a narrow lake plain. It extends northward from McCanna toward Edinburg in Walsh County. It is partly buried by lake and outwash deposits (*6*).

The delta plain is level and nearly level. Local relief generally is less than 5 feet, but in areas that have been modified by erosion, it is as much as 20 feet. The soils on the delta plain grade from sands and gravel along the northern border of the county to fine sands near Larimore and Kempton.

The beaches and areas between beaches are a succession of nearly level and gently sloping, narrow beach ridges separated by shallow, linear swales and broad flats. The beach ridges generally are not continuous. They cross the county from the northwest to the southeast and rise 3 to 15 feet above the surrounding areas (*6*). Local relief is less than 5 feet in the areas that separate the beach ridges. The broad and extensive flats commonly are bouldery. They are pitted by many poorly drained depressions in the south-central part of the county.

A large lake plain is in the eastern part of the county, and a narrow lake plain is along the eastern edge of the till plain. These lake plains are characterized by somewhat poorly drained flats and swells separated by poorly drained, shallow swales and sloughs. They are level areas that slope slightly to the northeast. Local relief is less than 1 foot.

water supply

The water supply in Grand Forks County is from surface and ground water sources (*9*). The Red Lake River of Minnesota and the Red River of the North supply water to Grand Forks and to the Grand Forks Air Force Base. The main source in other areas is ground water (*6*). The principal sources of ground water are the Dakota, Pierre, Emerado, Grand Forks, Thompson, Inkster, and Elk Valley aquifers.

The Dakota and Pierre aquifers are in preglacial sedimentary rocks. The Dakota aquifer is the most extensive source of ground water in the county. It underlies nearly all of the county, at depths ranging from 100 feet in the eastern part to more than 1,000 feet in the western part. The water from this aquifer is very saline. As a result, it generally is inferior as water for most domestic uses. In some areas it has such a high content of minerals that it is unsuitable for consumption by livestock. The water adversely affects most plants. On about 186,000 acres in the eastern part of the county, the soils are saline because of subirrigation by this water (*6*).

The Pierre aquifer underlies the till plain in the western part of the county. The water varies in quality and quantity from place to place. It generally is somewhat hard, toxic to most plants, and unsuitable for irrigation.

The rest of the major aquifers are in glacial drift. The Grand Forks and Thompson aquifers underlie the lake plain near the communities after which they are named. The Emerado aquifer underlies the area between beach ridges near Emerado. All three of these aquifers are small and are enclosed within glacial drift. Recharge is slow, and the chemical quality of the water is poor. Because of a high content of minerals, the water adversely affects plants and generally is unsuitable for irrigation and most other agricultural uses.

The Inkster aquifer underlies about 11 square miles of the areas between beach ridges directly west of Inkster. It is in fine to coarse sand that in a few areas contains gravel. It averages 27 feet thick. The maximum recorded thickness is 50 feet. The water generally is suitable for irrigation. It is hard, but the chemical quality is excellent. Tests indicate that wells can yield more than 500 gallons per minute in some areas. The limited extent and limited recharge area, however, significantly restrict the potential for future development.

The Elk Valley aquifer is an important source of ground water in the county because it has the best potential for irrigation. It averages about 34 feet thick and underlies 200 square miles of a delta plain. It is in material that generally is coarser textured in the northern areas and finer textured in the southern areas. Potential yields are more than 500 gallons per minute in the coarser textured material and progressively decrease as distance to the south increases. The chemical quality is good.

Small, isolated aquifers are common on the till plain and in areas between beach ridges. Generally, they are in sand and gravel and range from a few feet to 20 feet in thickness. The water quality varies, and the available quantity is small.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of

drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of soils on the general soil map of this county do not fully agree with those of the soils delineated on the general soil maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, and variation in the extent of the soils in the counties.

The associations in this survey have been grouped for broad interpretative purposes. Each of the broad groups and the associations in each group are described on the following pages.

dominantly level to moderately sloping, medium textured soils

These soils formed in till on till plains. They make up about 18 percent of the county. In most areas water runs off in natural drainageways. A few lakes and many marshes and depressions are evident.

1. Svea-Buse-Hamerly association

Deep, nearly level to moderately sloping, well drained to somewhat poorly drained, medium textured soils

This association is on knolls, ridges, and flats and in swales on till plains. Scattered depressions are throughout the association. The soils generally are steeper along breaks to the major drainageways.

This association makes up about 11 percent of the county. It is about 43 percent Svea soils, 22 percent Buse soils, 12 percent Hamerly soils, and 23 percent soils of minor extent (fig. 3).

The nearly level and gently sloping, moderately well drained Svea soils are on plane and concave side slopes. Typically, the surface soil is black loam about 17 inches thick. The subsoil is very dark grayish brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is calcareous and grayish brown in the upper part and is olive brown in the lower part.

The gently sloping and moderately sloping, well drained Buse soils are on the crest and shoulders of knolls and ridges. Typically, the surface layer is very dark gray loam about 8 inches thick. The upper part of the substratum is calcareous, light brownish gray loam. The lower part to a depth of about 60 inches is grayish brown, mottled clay loam.

The nearly level, somewhat poorly drained Hamerly soils are on the lower lying plane and slightly concave side slopes. Typically, the surface layer is black loam about 8 inches thick. The upper part of the substratum is calcareous, light brownish gray loam. The lower part to a depth of about 60 inches is olive, mottled loam.

Barnes, Cavour, Cresbard, Parnell, Sioux, and Vallers are the minor soils in this association. The well drained Barnes soils are on convex side slopes. They have a subsoil. The moderately well drained, alkali Cavour and Cresbard soils are on side slopes. The very poorly drained Parnell soils are in depressions. The excessively drained Sioux soils are on the crest and shoulders of knolls and ridges. The poorly drained Vallers soils are on low flats.

Most areas are used for cultivated crops. This association is suited to small grain and sunflowers. Soil blowing and water erosion are the main hazards if the major soils are cultivated.

This association is suitable as a site for sanitary facilities and buildings. The main limitations affecting these uses are a slow absorption of liquid waste, wetness, and a moderate shrink-swell potential.

2. Barnes-Cresbard-Cavour association

Deep, level to gently sloping, well drained and moderately well drained, medium textured soils

This association is on knolls, ridges, and flats and in swales on till plains. Scattered depressions are throughout the association. The soils generally are steeper along breaks to the major drainageways.

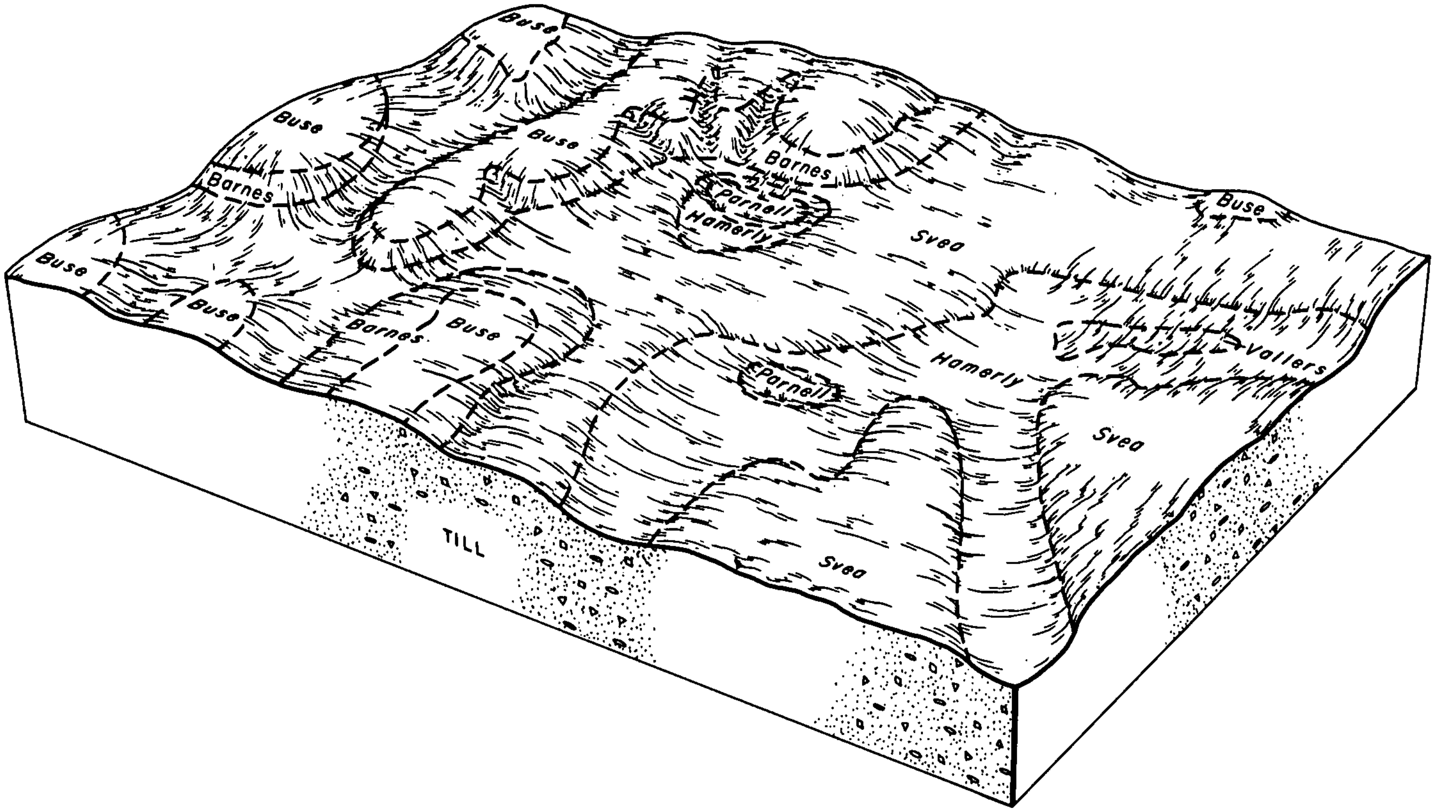

Figure 3.—Typical pattern of soils and parent material in the Svea-Buse-Hamerly association.

This association makes up about 7 percent of the county. It is about 37 percent Barnes soils, 24 percent Cresbard soils, 11 percent Cavour soils, and 28 percent soils of minor extent.

The nearly level and gently sloping, well drained Barnes soils are on convex side slopes and on the crest of the wider knolls and ridges. Typically, the surface layer is black loam about 11 inches thick. The subsoil is dark brown loam about 11 inches thick. The upper part of the substratum is calcareous, grayish brown loam. The lower part to a depth of about 60 inches is olive brown, mottled loam.

The level to gently sloping, moderately well drained, alkali Cresbard soils are on plane side slopes. Typically, the surface soil is loam about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is black clay loam about 12 inches thick. The upper part of the substratum is calcareous, dark grayish brown clay loam that is mottled below a depth of about 28 inches. The lower part to a depth of about 60 inches is grayish brown and dark grayish brown clay loam.

The level and nearly level, moderately well drained, alkali Cavour soils are on the convex lower side slopes. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is about 15 inches thick. It is black clay in the upper part and dark grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and grayish brown, mottled clay loam.

Buse, Hamerly, Manfred, Miranda, Parnell, Svea, and Vallers are the minor soils in this association. The well drained Buse soils are on the convex crest and shoulders of knolls and ridges. They do not have a subsoil. The somewhat poorly drained Hamerly and poorly drained Vallers soils are on the lower plane and concave slopes. In some areas the Vallers soils are moderately saline. The very poorly drained, alkali Manfred soils are in depressions and along drainageways. The somewhat poorly drained, alkali Miranda soils are in swales and on flats. The very poorly drained Parnell soils are in depressions. The moderately well drained Svea soils are on the plane and concave lower side slopes.

Most areas are used for cultivated crops or for hay and pasture. This association is suited to small grain and sunflowers. Severe alkalinity and a dense subsoil that

restricts root penetration are the main limitations if the major soils are cultivated.

This association is suitable as a site for sanitary facilities and buildings. The main limitations affecting these uses are a slow absorption of liquid waste and a moderate or high shrink-swell potential.

dominantly level and nearly level, fine textured to medium textured soils

These soils formed in glaciolacustrine deposits and glaciolacustrine deposits overlying till. They are on glacial lake plains and in areas between old glacial beaches. They make up about 38 percent of the county. In most areas water runs off into natural drainageways or is removed by constructed drains and by road ditches.

3. Nutley-Aberdeen association

Deep, level, well drained and moderately well drained, fine textured soils

This association is on broad flats on glacial lake plains. It makes up about 1 percent of the county. It is about 41 percent Nutley soils, 16 percent Aberdeen soils, and 43 percent soils of minor extent.

The well drained Nutley soils are on plane and slightly convex slopes. Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is about 15 inches thick. It is very dark grayish brown silty clay in the upper part and dark grayish brown and very dark grayish brown, mottled clay in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay.

The moderately well drained, alkali Aberdeen soils are in the slightly lower lying areas. Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is about 31 inches of very dark grayish brown silty clay and clay. In the lower part it is mottled and has masses of gypsum crystals. The substratum to a depth of about 60 inches is calcareous, light brownish gray, mottled clay.

Bearden, Exline, LaDelle, Overly, and Wahpeton are the minor soils in this association. The somewhat poorly drained Bearden soils are on the lower lying plane and slightly convex slopes. The somewhat poorly drained, alkali Exline soils are on the lower lying concave slopes. The moderately well drained LaDelle and Wahpeton soils are on flood plains. The moderately well drained Overly soils are on the higher lying plane and slightly concave slopes.

Most areas are used for cultivated crops. This association is suited to small grain, sunflowers, potatoes, and sugar beets. Poor workability, moderate alkalinity, and a dense subsoil that restricts root penetration are the main limitations if the major soils are cultivated.

This association is suitable as a site for sanitary facilities and buildings. The major limitations affecting these uses are a slow absorption of liquid waste and a high shrink-swell potential.

4. Glyndon-Gardena association

Deep, level and nearly level, somewhat poorly drained and moderately well drained, medium textured soils

This association occurs as areas of slight swells and swales on glacial lake plains. Many small, distinct depressions are in some areas. The soils generally are level and nearly level but are steeper along breaks to some drainageways and on a few ridges.

This association makes up about 9 percent of the county. It is about 56 percent Glyndon soils, 18 percent Gardena soils, and 26 percent soils of minor extent.

The somewhat poorly drained Glyndon soils are on plane and slightly convex slopes and in swales. Typically, the surface soil is black silt loam about 13 inches thick. The upper part of the substratum is calcareous, dark grayish brown and light olive brown, mottled silt loam. The next part is olive brown, mottled silt loam. The lower part to a depth of about 60 inches is olive brown, stratified very fine sandy loam.

The moderately well drained Gardena soils are on the higher lying plane and slightly concave slopes. Typically, the surface soil is black silt loam about 14 inches thick. The subsoil is silt loam about 12 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The upper part of the substratum is calcareous, pale brown silt loam. The next part is brown silt loam. The lower part to a depth of about 60 inches is yellowish brown, mottled silt loam and very fine sandy loam.

Borup, Perella, Tiffany, and Zell are the minor soils in this association. The poorly drained Borup, Perella, and Tiffany soils are in the deeper swales or depressions or in seepy areas. The well drained Zell soils are on the convex crest and shoulders of knolls and ridges.

Most areas are used for cultivated crops. This association is suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing is the main hazard if the major soils are cultivated.

This association is suitable as a site for sanitary facilities and buildings. The main limitation affecting these uses is wetness.

5. Bearden association

Deep, level, somewhat poorly drained, moderately fine textured and fine textured soils

This association occurs as areas of slight swells and swales on glacial lake plains. Many small, distinct depressions are in some areas. The soils generally are level but are steeper along breaks to some drainageways. Excess surface water is removed from most areas by constructed drains.

This association makes up about 15 percent of the county. It is about 77 percent Bearden soils and 23 percent soils of minor extent.

Typically, the Bearden soils have a surface layer of black silty clay loam about 10 inches thick. The upper

part of the substratum is calcareous, gray silty clay loam. The next part is light olive brown, mottled silt loam. The lower part to a depth of about 60 inches is grayish brown and light brownish gray, mottled silty clay loam.

Colvin, Glyndon, Ojata, Overly, and Perella are the minor soils in this association. The poorly drained Colvin, Ojata, and Perella soils are on low lying flats and in swales or depressions. Ojata soils are very strongly saline. The somewhat poorly drained Glyndon soils are in positions on the landscape similar to those of the Bearden soils. They contain less clay than those soils. The moderately well drained Overly soils are on the higher lying plane and slightly concave slopes.

Most areas are used for cultivated crops. This association is suited to small grain, sunflowers, sugar beets, and potatoes. If the major soils are cultivated, the main concerns of management are soil blowing and wetness.

This association is poorly suited to sanitary facilities and building site development. The main limitations affecting these uses are wetness, a slow absorption of liquid waste, and a moderate shrink-swell potential.

6. Antler-Gilby-Svea association

Deep, level and nearly level, somewhat poorly drained and moderately well drained, medium textured soils

This association is on broad flats in areas between old glacial beaches. Many small, distinct depressions are in some areas. The soils generally are level and nearly level but are steeper along breaks to some drainageways and on beach ridges.

This association makes up about 13 percent of the county. It is about 35 percent Antler soils, 19 percent Gilby soils, 12 percent Svea soils, and 34 percent soils of minor extent (fig. 4).

The somewhat poorly drained Antler soils are on broad flats. Typically, the surface layer is black silt loam about 9 inches thick. The upper part of the substratum is calcareous, gray silt loam. The next part is calcareous, light olive brown silty clay loam. The lower part to a depth of about 60 inches is light olive brown, mottled silt loam and clay loam.

The somewhat poorly drained Gilby soils are on broad flats. Typically, the surface soil is black loam about 12 inches thick. The upper part of the substratum is calcareous, grayish brown, mottled silt loam. The next part is light olive brown, mottled loam. The lower part to a depth of about 60 inches is gray and olive brown, mottled clay loam.

The moderately well drained Svea soils are on the higher lying plane and concave slopes. Typically, the surface soil is black loam about 19 inches thick. The subsoil is very dark grayish brown clay loam about 12 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is calcareous and grayish brown in the upper part and olive brown in the lower part.

Arvilla, Parnell, Sioux, Tonka, Wyndmere, and Vallers are the minor soils in this association. The somewhat excessively drained Arvilla and excessively drained Sioux soils are on the crest and sides of beach ridges. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The somewhat poorly drained Wyndmere and poorly drained Vallers soils are on low lying flats and in seepy areas that parallel beach ridges.

Most areas are used for cultivated crops. This association is suited to small grain and sunflowers. Soil blowing and wetness are the main concerns of management if the major soils are cultivated. Also, in most areas of the Antler and Svea soils, stones and boulders restrict cultivation.

This association is poorly suited to sanitary facilities and building site development. The main limitations affecting these uses are wetness and a slow absorption of liquid waste.

dominantly level, moderately fine textured, saline soils

These soils formed in glaciolacustrine deposits and in glaciolacustrine deposits overlying till. They are on glacial lake plains and in areas between old glacial beaches. They are moderately saline to very strongly saline. They make up about 23 percent of the county. Some areas are undrained, but most are drained by constructed drains and road ditches. A few sloughs are evident.

7. Bearden-Antler association

Deep, level, somewhat poorly drained, moderately fine textured, saline soils

This association is on slight swells, in swales, and on broad flats on glacial lake plains and in areas between old glacial beaches. Many small, distinct depressions are in some areas. The soils generally are level but are steeper along breaks to some drainageways and on beach ridges.

This association makes up about 18 percent of the county. It is about 64 percent Bearden soils, 17 percent Antler soils, and 19 percent soils of minor extent.

The Bearden soils are on slight swells and in swales on glacial lake plains. Typically, the surface soil is black silty clay loam about 13 inches thick. It contains salt crystals. The substratum to a depth of about 60 inches is silt loam. The upper part is very dark gray and mottled. It is calcareous and contains salt crystals. The next part is olive brown and mottled. The lower part is multicolored.

The Antler soils are on broad flats in areas between old glacial beaches. Typically, the surface layer is black silty clay loam about 8 inches thick. It contains salt crystals. The upper part of the substratum is calcareous, brownish gray silty clay loam. The next part is light olive brown fine sandy loam. The lower part to a depth of about 60 inches is olive brown, mottled clay loam.

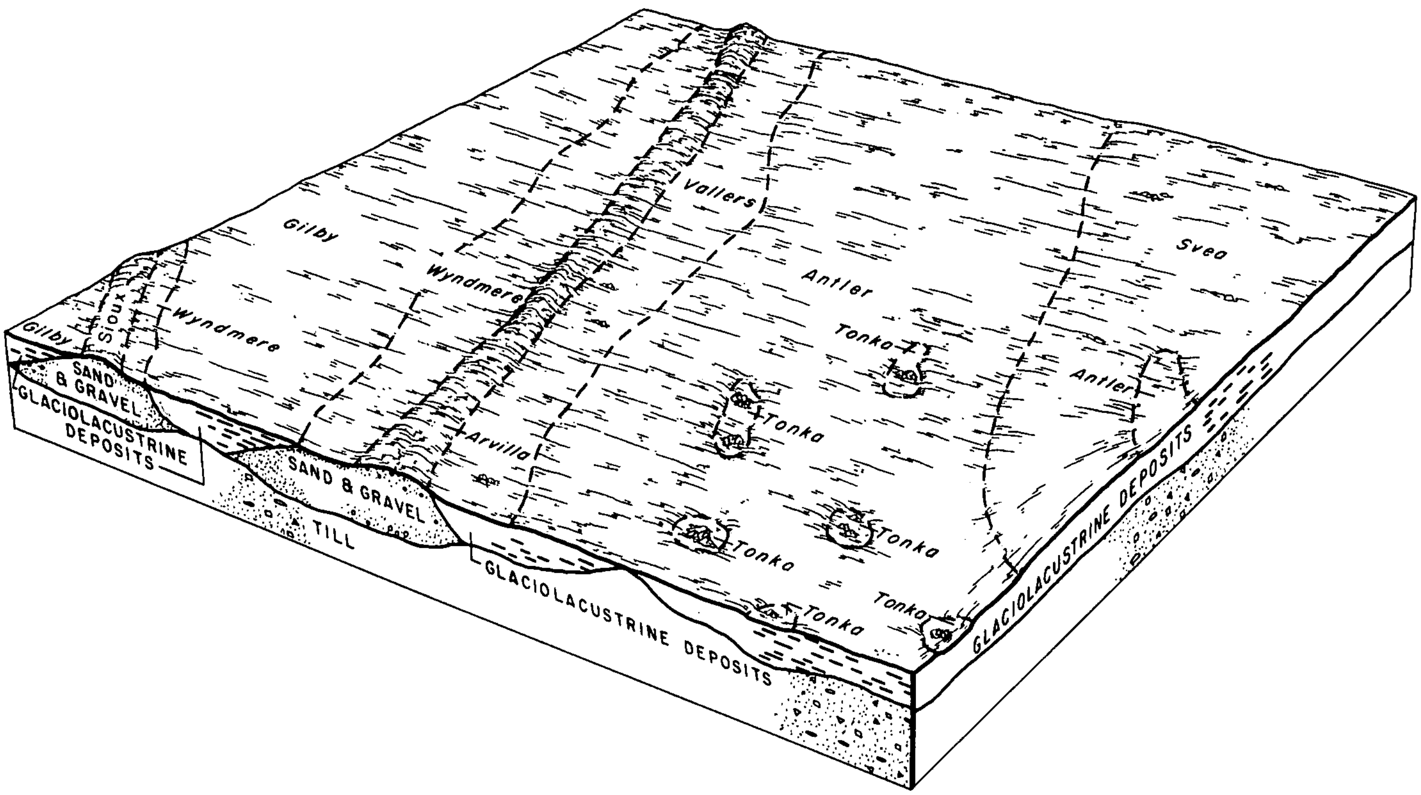

Figure 4.—Typical pattern of soils and parent material in the Antler-Gilby-Svea association.

The major soils generally are moderately saline. In some areas, however, they are free of salts.

Colvin, Ojata, Perella, and Tonka are the minor soils in this association. The poorly drained Colvin and Perella soils are in the lower lying areas. They are nonsaline. The poorly drained Ojata soils are in sloughs or on the lower lying flats. They are very strongly saline. The poorly drained Tonka soils are in depressions in the areas between old glacial beaches.

Most areas are used for cultivated crops. This association is suited to small grain, sunflowers, sugar beets, potatoes, and pasture. Salinity, wetness, and soil blowing are the main concerns of management if the major soils are cultivated. Also, in most of the areas between old glacial beaches, stones and boulders restrict cultivation.

This association is poorly suited to sanitary facilities and building site development. The main limitations affecting these uses are wetness and a slow absorption of liquid waste.

8. Ojata association

Deep, level, poorly drained, moderately fine textured, very strongly saline soils

This association is on low lying flats and in sloughs and swales on glacial lake plains and in areas between old glacial beaches. The soils generally are level but are steeper along breaks to drainageways and around sloughs.

This association makes up about 5 percent of the county. It is about 78 percent Ojata soils and 22 percent soils of minor extent.

Typically, the surface layer of the Ojata soil is black silty clay loam about 8 inches thick. It contains salt crystals. The upper part of the substratum is calcareous, gray, mottled silt loam. It contains salt crystals. The next part is dark grayish brown, mottled, very finely stratified silt loam. The lower part to a depth of about 60 inches is dark grayish brown and olive brown, mottled silt loam.

Antler, Bearden, Colvin, and Lallie are the minor soils in this association. The somewhat poorly drained Antler and Bearden soils are on the higher lying slopes. They are moderately saline or nonsaline. The Colvin soils are in positions on the landscape similar to those of the Ojata soils. They are nonsaline. The very poorly drained Lallie soils are in sloughs and are frequently ponded.

Most areas are used as pasture or as wildlife habitat. This association generally is unsuited to most cultivated crops because of the very strong salinity.

This association is poorly suited to sanitary facilities and building site development. The main limitations affecting these uses are wetness and a slow absorption of liquid waste.

dominantly level to gently sloping, medium textured and moderately coarse textured soils

These soils formed in glaciofluvial and glaciolacustrine deposits on delta plains and beaches. They make up about 18 percent of the county. In most areas water is removed by deep seepage, natural runoff, or field drains.

9. Embden-Inkster association

Deep, level to gently sloping, moderately well drained, moderately coarse textured soils

This association is on broad plains and on low knolls or ridges on delta plains and on beaches. The soils generally are level to gently sloping but are steeper along breaks to some drainageways.

This association makes up about 6 percent of the county. It is about 40 percent Embden soils, 31 percent Inkster soils, and 29 percent soils of minor extent.

The level to gently sloping Embden soils are on the plane and slightly concave slopes in areas dominated by siliceous material. Typically, the surface layer is black fine sandy loam about 11 inches thick. The subsoil is very dark gray fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is fine sandy loam. It is dark brown in the upper part and dark grayish brown in the lower part.

The level and nearly level Inkster soils are on the plane and slightly concave slopes in areas dominated by weathered shale. Typically, the surface layer is black sandy loam about 6 inches thick. The subsoil is very dark gray sandy loam about 18 inches thick. It is mottled in the lower part. The upper part of the substratum is dark grayish brown, mottled sandy loam. The lower part to a depth of about 60 inches is dark olive gray, mottled loamy sand.

Arveson, Sioux, Tiffany, Walsh, and Wyndmere are the minor soils in this association. The poorly drained Arveson soils are in swales and seepy areas. The excessively drained Sioux soils are on the convex crest and shoulders of knolls and ridges. The poorly drained Tiffany and somewhat poorly drained Wyndmere soils are on the lower lying flats and in swales or depressions. The moderately well drained Walsh soils are on delta plains. They contain more clay than the major soils.

Most areas are used for cultivated crops. This association is suited to small grain, sunflowers, and potatoes. Soil blowing and droughtiness are the main concerns of management if the major soils are cultivated.

This association is suited to sanitary facilities and building site development. The main limitation affecting these uses is wetness. Also, the liquid waste from sanitary facilities can pollute ground water.

10. Wyndmere-Tiffany-Arveson association

Deep, level, somewhat poorly drained and poorly drained, medium textured and moderately coarse textured soils

This association occurs as areas of broad flats, swales, and depressions on delta plains and as seepy areas on beaches. The soils generally are level but are steeper on some beaches and along breaks to drainageways.

This association makes up about 7 percent of the county. It is about 34 percent Wyndmere soils, 15 percent Tiffany soils, 14 percent Arveson soils, and 37 percent soils of minor extent (fig. 5).

The somewhat poorly drained Wyndmere soils are in plane and slightly concave areas on broad flats, in shallow swales, and in seepy areas. Typically, the surface layer is black sandy loam about 10 inches thick. The upper part of the substratum is calcareous, gray and grayish brown sandy loam. The next part is brown loamy fine sand. The lower part to a depth of about 60 inches is pale brown, mottled fine sand.

The poorly drained Tiffany soils are in depressions, in the deeper swales, and on the lower lying flats. Typically, the surface layer is black fine sandy loam about 10 inches thick. The subsurface layer is very dark gray, mottled fine sandy loam about 5 inches thick. The next 8 inches is dark grayish brown, mottled fine sandy loam. The upper part of the substratum is olive brown, mottled fine sandy loam. The lower part to a depth of about 60 inches is light olive brown and light brownish gray, mottled, stratified fine sandy loam, loamy fine sand, and loamy very fine sand.

The poorly drained Arveson soils are in the deeper swales and in seepy areas. Typically, the surface layer is black loam about 11 inches thick. The subsurface layer is calcareous, very dark gray sandy loam about 4 inches thick. The upper part of the substratum is calcareous, dark gray and dark grayish brown sandy loam. The lower part to a depth of about 60 inches is dark grayish brown sand.

Arvilla, Divide, Embden, and Marysland are the minor soils in this association. The somewhat excessively drained Arvilla soils are on the crest and sides of ridges and knolls. The moderately well drained Embden soils are on the higher lying plane and slightly concave slopes. The somewhat poorly drained Divide and poorly drained Marysland soils are in swales and seepy areas. Their substratum contains more gravel than that of the major soils.

Most areas are used for cultivated crops. This association is suited to small grain, sunflowers, and potatoes. Wetness and soil blowing are the main concerns of management if the major soils are cultivated.

This association is poorly suited to sanitary facilities and building site development. The main limitation affecting these uses is the wetness caused by a

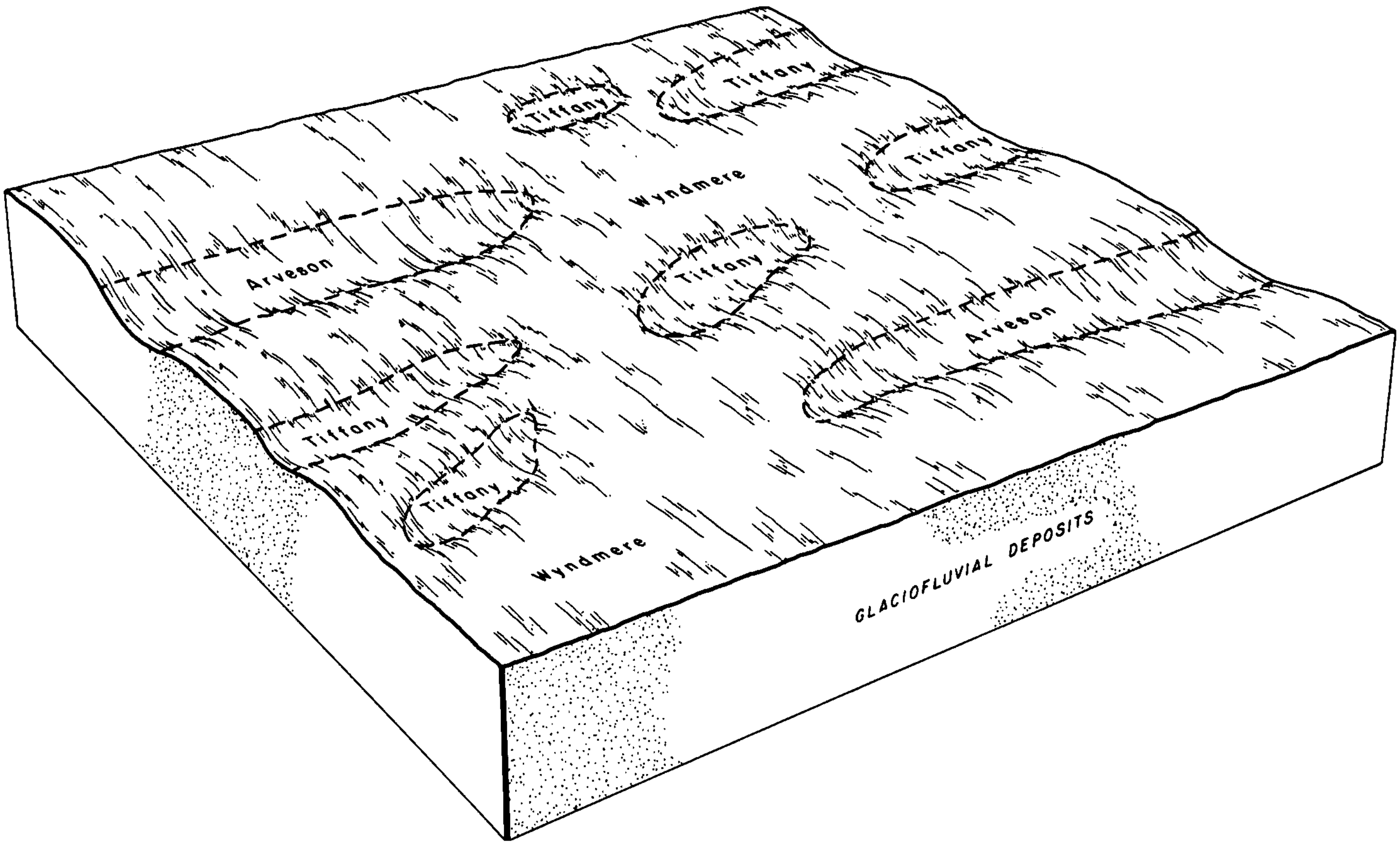

Figure 5.—Typical pattern of soils and parent material in the Wyndmere-Tiffany-Arveson association.

seasonal high water table. Also, ponding is a hazard in some areas of the Arveson and Tiffany soils.

11. Arvilla-Hecla association

Deep, nearly level and gently sloping, somewhat excessively drained and moderately well drained, moderately coarse textured soils

This association occurs as areas of gentle swells, swales, and low knolls on delta plains and beaches. The soils generally are nearly level and gently sloping but are steeper along breaks to the major drainageways.

This association makes up about 5 percent of the county. It is about 46 percent Arvilla soils, 24 percent Hecla soils, and 30 percent soils of minor extent.

The somewhat excessively drained Arvilla soils are on slightly convex slopes and on the crest of the wider knolls and ridges. Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is very dark brown sandy loam about 11 inches thick. The upper part of the substratum is dark brown sand. The lower part to a depth of about 60 inches is brown gravelly coarse sand.

The moderately well drained Hecla soils are on plane and slightly concave slopes. Typically, the surface layer is black fine sandy loam about 8 inches thick. The next 9 inches is very dark grayish brown fine sandy loam. The upper part of the substratum is yellowish brown, mottled fine sand. The next part is dark brown loamy sand. The lower part to a depth of about 60 inches is dark grayish brown fine sand.

Maddock, Sioux, Tiffany, and Wyndmere are the minor soils in this association. The well drained Maddock and excessively drained Sioux soils are on the crest and shoulders of knolls and ridges. The poorly drained Tiffany soils are in depressions and swales. The somewhat poorly drained Wyndmere soils are on flats and in swales.

Most areas are used for cultivated crops. This association is suited to small grain and sunflowers. Soil blowing and droughtiness are the main concerns of management if the major soils are cultivated.

This association is suited to sanitary facilities and building site development. The liquid waste from sanitary facilities, however, can pollute ground water.

dominantly level to moderately steep, medium textured and moderately fine textured soils that are subject to flooding

These soils formed in alluvium on flood plains, stream terraces, and channeled bottom land. They are subject to stream overflow. They make up about 3 percent of the county.

12. LaDelle-Cashel association

Deep, level to moderately steep, moderately well drained and somewhat poorly drained, medium textured and moderately fine textured soils

This association is on flood plains, bottom land, and terraces along the major streams (fig. 6). Meandering channels generally dissect the bottom land into small, irregularly shaped areas. Some areas are isolated by deep channels and steep escarpments.

This association makes up about 3 percent of the county. It is about 47 percent LaDelle soils, 30 percent Cashel soils, and 23 percent soils of minor extent.

The level to gently sloping, moderately well drained LaDelle soils are on flood plains and terraces. Typically, the surface soil is black silt loam about 34 inches thick. The substratum to a depth of about 60 inches is silty clay loam. It is dark grayish brown and dark gray and mottled in the upper part and is black in the lower part.

The nearly level to moderately steep, somewhat poorly drained Cashel soils are on flood plains and channeled bottom land. Typically, the surface layer is very dark gray silty clay loam about 9 inches thick. The upper part of the substratum is very dark gray, finely stratified silty clay loam. The next part is black silty clay loam. The lower part to a depth of about 60 inches is very dark gray, mottled silty clay loam.

Lamoure, Velva, Wahpeton, and Zell are the minor soils in this association. The poorly drained Lamoure soils are in the lower lying areas on flood plains. The

Figure 6.—A flooded area of the LaDelle-Cashel association.

well drained Velva and moderately well drained Wahpeton soils are on flood plains. The well drained Zell soils are on breaks to drainageways.

Most areas are used for cultivated crops or support native hardwoods. This association generally is suited to small grain, sunflowers, sugar beets, and potatoes. In the moderately sloping to moderately steep areas, however, it generally is unsuited to cultivated crops because of susceptibility to water erosion. Measures that control flooding and soil blowing and improve tilth and fertility are the main management needs if the level to gently sloping areas are cultivated.

This association generally is unsuitable as a site for sanitary facilities and buildings. The flooding is the major hazard affecting these uses.

broad land use considerations

In 1977, about 80 percent of the land in Grand Forks County was used for cultivated crops (*12*). The rest was used for pasture and hay, urban development, recreation, and wildlife habitat. Deciding which areas should be used for urban development, transportation corridors, or recreational facilities and which should be preserved as cropland is becoming an increasingly important issue in the survey area. The general soil map in this soil survey is a useful tool for those who make broad land use decisions in Grand Forks County.

The soils in Grand Forks County generally are suited to cultivated crops. Salinity is a severe limitation, however, if the Ojata and Bearden-Antler associations are cultivated. Flooding is a hazard on the LaDelle-Cashel association. Wetness is the main limitation on the Bearden, Antler-Gilby-Svea, and Wyndmere-Tiffany-Arveson associations. Soil blowing is a hazard in most areas. It is especially severe on the Embden-Inkster and Arvilla-Hecla associations. A dense, alkali subsoil restricts root penetration in areas of the Barnes-Cresbard-Cavour and Nutley-Aberdeen associations.

Pasture or hay is the second most extensive land use in the county. Most of the soils have good potential for this use, but cropland is the preferred use. The soil limitations that affect cropland also tend to affect pasture and hayland, but generally to a lesser extent. The saline soils in the Ojata and Bearden-Antler associations have poor potential for pasture or hay, though they probably are best suited to this use.

The distribution of urban land in Grand Forks County generally is not correlated with soil potential. It apparently has been influenced by other considerations. The potential of some soils is poor for urban uses. The LaDelle-Cashel association has very poor potential for urban development because it is highly susceptible to stream overflow. The Arvilla-Hecla, Embden-Inkster, and Glyndon-Gardena associations have good potential for urban development. The Bearden, Antler-Gilby-Svea, and Bearden-Antler associations are limited as sites for sanitary facilities because of wetness and a slow absorption of liquid waste. The potential of these associations for urban development can be improved by installing a municipal sewer system. If both of the major soils in the Arvilla-Hecla association or the Inkster soils in the Embden-Inkster association are used as septic tank absorption fields, the effluent can pollute ground water because these soils are rapidly permeable.

Recreational development is not extensive in Grand Forks County. Areas where the soils have good potential for recreational uses are throughout the county. Most are areas of the Glyndon-Gardena, Embden-Inkster, and Arvilla-Hecla associations. The other associations are limited by flooding, wetness, or soil conditions that adversely affect the plant cover.

The extent of wildlife habitat is very limited in the county. The soils generally have good or fair potential for one or more types of wildlife habitat. Those used for wildlife habitat generally have one or more limitations that restrict their potential for other uses.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and identifies the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Bearden silty clay loam is one of several phases in the Bearden series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Hamerly-Tonka complex, 0 to 3 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

The descriptions, names, and delineations of soils on the detailed soil maps of this county do not fully agree with those of the soils delineated on the detailed maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

2—Parnell silt loam. This deep, level, very poorly drained soil is in depressions in till plains and in areas between old glacial beaches. Excess surface water frequently ponds on the surface for long periods during spring runoff and heavy rainfall. Individual areas range from 5 to about 15 acres.

Typically, the surface layer is black silt loam about 10 inches thick. The subsoil is about 34 inches thick. It is black silty clay loam in the upper part, black, mottled silty clay loam in the next part, and very dark gray, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown, mottled loam. In the shallower depressions the soil is poorly drained and has a mottled subsurface layer.

Included with this soil in mapping are small areas of Antler and Hamerly soils and the moderately saline and nonsaline Vallers soils. These soils make up 5 to 15 percent of the unit. They have a calcareous layer within a depth of 16 inches. They are in the higher areas that surround the depressions.

The Parnell soil is slowly permeable. Available water capacity is high. Runoff is ponded. A seasonal high water table is above or near the surface. The shrink-swell potential is high.

Most areas are used as wetland wildlife habitat. Much of the wetland wildlife habitat in the county is in areas of this soil.

This soil generally is unsuited to pasture, hay, and most cultivated crops because of excessive wetness. It generally is unsuited to windbreaks and environmental plantings unless it is drained. Excessive wetness is a critical limitation affecting the survival, growth, and vigor of trees and shrubs.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the ponding. Also, the slow permeability is a limitation in septic tank absorption fields and the high shrink-swell potential a limitation on building sites. Soils that are better suited to these uses generally are nearby.

The capability subclass is Vw.

3—Vallers loam. This deep, level, poorly drained soil is in seepy areas and on flats on till plains and between old glacial beaches. Excess surface water ponds in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from 5 to about 30 acres.

Typically, the surface layer is black loam about 8 inches thick. The substratum to a depth of about 60 inches is clay loam. It is calcareous to a depth of about 44 inches. It is dark gray in the upper part, light olive gray and mottled in the next part, and olive gray and mottled in the lower part. In some areas the surface layer is silt loam or clay loam. In the slightly higher lying areas, the soil is somewhat poorly drained. In the areas between old beaches, a thin cobbly or sandy layer commonly is in the upper part of the substratum.

Included with this soil in mapping are small areas of Parnell soils and the moderately saline Vallers soils. These soils make up 5 to 15 percent of the unit. Parnell soils are very poorly drained and are in depressions. They have a fine textured subsoil and contain less lime than the Vallers soil.

The Vallers soil is moderately slowly permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is above the surface or within a depth of 2.5 feet.

Most areas are used for cultivated crops or for hay, pasture, or wetland wildlife habitat. This soil is suited to small grain and sunflowers. Wetness is the main limitation if cultivated crops are grown. If surface drains are installed, tillage and seeding generally can be more timely. Suitable outlets for drains, however, generally are not available, particularly in the areas on till plains. The soil is highly susceptible to soil blowing. Field windbreaks, stripcropping, buffer strips, and crop residue management help to control soil blowing.

A cover of pasture plants or hay is effective in controlling soil blowing. If this soil is drained, forage production is good. Suitable drainage outlets, however, generally are not available. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

Unless drained, this soil generally is unsuited to the trees and shrubs grown as windbreaks and environmental plantings. The excessive wetness is a critical limitation affecting survival, growth, and vigor.

This soil is poorly suited to septic tank absorption fields and building site development. The ponding is the main hazard. Also, the moderately slow permeability is a limitation in septic tank absorption fields. Soils that are better suited to these uses generally are nearby.

The capability subclass is IVw.

4—Arveson loam. This deep, level, poorly drained soil is in swales and seepy areas on delta plains and between old glacial beaches. The natural drainage pattern is poorly defined. Excess surface water frequently ponds in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from 5 to about 800 acres.

Typically, the surface soil is about 15 inches thick. It is about 11 inches of black loam over 4 inches of very dark gray, calcareous sandy loam. The upper part of the substratum is calcareous, dark gray and dark grayish brown sandy loam. The lower part to a depth of about 60 inches is dark grayish brown sand. On some swells the soil is somewhat poorly drained. In some places the surface layer is sandy loam. In other places the soil does not have a calcareous layer within a depth of 16 inches. In some areas it contains more clay in the upper part. In other areas the substratum is silt loam or very fine sandy loam.

Included with this soil in mapping are small areas of Embden and Rauville soils. These soils make up 1 to 10 percent of the unit. The moderately well drained Embden soils are on the higher lying slopes. The very poorly drained Rauville soils are in seepy areas and on bottom land. They contain more clay and less sand than the Arveson soil.

The Arveson soil is moderately rapidly permeable. Available water capacity is moderate. Runoff is ponded. A seasonal high water table is above or near the surface.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers only if excess surface water is removed. The water is removed from most areas by natural runoff or deep seepage or by constructed drains. The soil is suitable for late seeded crops in most years. It is highly susceptible to soil blowing. Field windbreaks, crop residue management, stripcropping, and buffer strips help to control soil blowing.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition. The ponded water interferes with haying in some years.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development. The ponding is the

main hazard. Surface drains and other measures that divert runoff can control the ponding, but the seasonal high water table is a continuing limitation. Soils that are better suited to these uses generally are nearby.

The capability subclass is IIIw.

8—Colvin silty clay loam. This deep, level, poorly drained soil is on broad flats and in shallow swales on glacial lake plains and in seepy areas. The natural drainage pattern is poorly defined. Excess surface water occasionally ponds in the lower lying areas for short periods during spring runoff and heavy rainfall. Individual areas range from 5 to about 50 acres.

Typically, the surface layer is black silty clay loam about 11 inches thick. The upper part of the substratum is calcareous, dark gray and gray, mottled silty clay loam. The next part is grayish brown, mottled silt loam. The lower part to a depth of about 60 inches is grayish brown, mottled silty clay loam. In some places the surface layer is silt loam. In other places the soil contains less clay throughout. In the deeper parts of some swales and depressions, the calcareous layer is 16 or more inches below the surface. On some swells the soil is somewhat poorly drained.

Included with this soil in mapping are small areas of the moderately saline Bearden soils. These soils make up as much as 5 percent of the unit. They are somewhat poorly drained and are on the higher lying swells.

The Colvin soil is moderately slowly permeable. Available water capacity is high. Runoff is ponded. A seasonal high water table is above or near the surface. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes if excess surface water is removed. It is suitable for late seeded crops in most years. Wetness and soil blowing are the main concerns of management. Excess surface water is removed from most areas by natural runoff or deep seepage or by constructed drains. Field windbreaks, stripcropping, crop residue management, and buffer strips help to control soil blowing.

A cover of hay or pasture plants is effective in controlling soil blowing. The ponded water interferes with haying in some years. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development. The ponding is the main hazard. Also, the shrink-swell potential is a limitation on building sites and the moderately slow permeability a limitation in septic tank absorption fields. Surface drains help to control the ponding, but the seasonal high water table is a continuing limitation. Soils that are better suited to these uses generally are nearby.

The capability subclass is IIw.

10—Lamoure silty clay loam. This deep, level, poorly drained soil is on flood plains that generally are dissected into small, irregularly shaped areas by meandering channels. Many areas are isolated by deep channels or steep escarpments. This soil is frequently flooded for brief periods during spring runoff and heavy rainfall. Individual areas generally are narrow and sinuous and range from 5 to about 100 acres.

Typically, the surface soil is about 41 inches thick. It is about 15 inches of black silty clay loam over 26 inches of black silt loam. The substratum to a depth of about 60 inches is mottled silt loam. It is very dark gray in the upper part and dark gray in the lower part. In some areas the surface layer is silt loam. In places a calcareous layer is within a depth of 16 inches.

Included with this soil in mapping are small areas of the moderately saline Bearden soils and small areas of LaDelle and Rauville soils. These soils make up 1 to 15 percent of the unit. Bearden soils are somewhat poorly drained. They have a calcareous layer within a depth of 16 inches. The moderately well drained LaDelle soils are in the higher lying areas. The very poorly drained Rauville soils are on bottom land and in seepy areas.

The Lamoure soil is moderately permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at or near the surface.

Most areas are used for pasture or hay. A cover of pasture plants or hay is effective in controlling soil blowing. If a drainage system is installed, forage production is good. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition. Wetness interferes with haying in some years.

This soil is suited to small grain and sunflowers. The wetness caused by the seasonal high water table is the main limitation. Also, the seasonal flooding is a hazard and the soil is highly susceptible to soil blowing. If surface drains are installed, tillage and seeding generally can be more timely. Cover crops, buffer strips, and crop residue management help to control soil blowing.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the flooding and the wetness. Soils that are better suited to these uses generally are in nearby higher lying areas.

The capability subclass is IVw.

11—Dovray clay. This deep, level, poorly drained soil is in depressions, in oxbows, and along drainageways on glacial lake plains and till plains. The natural drainage pattern is poorly defined, but excess surface water is removed from most areas by constructed drains. Undrained areas frequently are ponded by excess

surface water. The drainageways are subject to stream overflow. Individual areas range from 5 to about 80 acres.

Typically, the surface soil is black clay about 51 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is gray, mottled silt loam. In some places the surface soil is silty clay. In other places it is less than 51 inches thick. In some areas the soil is very poorly drained.

Included with this soil in mapping are small areas of the somewhat poorly drained Bearden soils on the adjacent lake plains. These soils make up 1 to 5 percent of the unit. They have a calcareous layer within a depth of 16 inches and contain less clay than the Dovray soil.

The Dovray soil is very slowly permeable. Available water capacity is moderate. Runoff is ponded. A seasonal high water table is above or near the surface. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes if excess water is removed. It is suitable for late seeded crops in most years. Wetness and soil blowing are the main concerns of management. Field windbreaks, stripcropping, crop residue management, and buffer strips help to control soil blowing. Tilling the soil and keeping it in good tilth are difficult because of the high content of clay. Tilling at the proper moisture content helps to prevent surface compaction and the destruction of soil structure.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings. The ponding is the main hazard. Also, the very slow permeability is a limitation in septic tank absorption fields and the high shrink-swell potential a limitation on building sites. Soils that are better suited to these uses generally are in nearby higher lying areas.

The capability subclass is IIIw.

12—Svea loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on till plains and in areas between old glacial beaches. It is stony in some areas. Individual areas range from 5 to about 400 acres.

Typically, the surface soil is black loam about 19 inches thick. The subsoil is very dark grayish brown clay loam about 12 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is calcareous and grayish brown in the upper part and olive brown in the lower part. In some places the soil is well drained and has a thinner surface layer. In some areas, generally on the lower lying concave side slopes, it is somewhat poorly drained and has a calcareous layer within a depth of 16 inches or has a mottled subsoil.

Included with this soil in mapping are small areas of Cresbard, Parnell, and Sioux soils and the moderately saline and nonsaline Vallers soils. These soils make up 1 to 10 percent of the unit. The alkali Cresbard soils are on plane side slopes. The very poorly drained Parnell soils are in depressions. The excessively drained Sioux soils are on the crest of knolls and ridges. They are shallow or very shallow over sand and gravel. The poorly drained Vallers soils are on low lying flats. They have a calcareous layer within a depth of 16 inches.

The Svea soil is moderately slowly permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Returning crop residue to the soil and applying the proper kinds and amounts of fertilizer improve tilth and fertility and increase the organic matter content.

A cover of pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the commonly grown trees and shrubs. No critical limitations affect the trees and shrubs.

This soil is suitable as a site for septic tank absorption fields and buildings. The slow absorption of liquid waste is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderate shrink-swell potential is a limitation on building sites, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The wetness is a limitation on sites for dwellings with basements. Subsurface drains help to prevent seepage into basements.

The capability subclass is IIc.

13B—Barnes loam, 3 to 6 percent slopes. This deep, undulating, well drained soil is on till plains. Slopes are abruptly terminated by short, steep escarpments in some areas adjacent to streams. Individual areas range from about 5 to more than 100 acres.

Typically, the surface soil is black loam about 11 inches thick. The subsoil is dark brown loam about 11 inches thick. The substratum to a depth of about 60 inches is loam. It is calcareous and grayish brown in the upper part and olive brown and mottled in the lower part. On some concave side slopes, the surface soil is more than 16 inches thick. In some areas on the crest of knolls, the soil does not have a subsoil.

Included with this soil in mapping are small areas of Cresbard, Hamerly, Parnell, and Sioux soils and the moderately saline Vallers soils. These soils make up 1 to

15 percent of the unit. The alkali Cresbard soils are on side slopes. The somewhat poorly drained Hamerly soils are on concave side slopes. They have a calcareous layer within a depth of 16 inches. The very poorly drained Parnell soils are in depressions. The excessively drained Sioux soils are on the crest of knolls and ridges. They are shallow or very shallow over sand and gravel. The poorly drained Vallers soils are on low lying flats.

The Barnes soil is moderately slowly permeable. Available water capacity is high. Runoff is medium. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Water erosion is the main hazard. It can be controlled by grassed waterways and diversions. Returning crop residue to the soil increases the infiltration rate and reduces the runoff rate.

A cover of pasture plants or hay is effective in controlling water erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to nearly all of the trees and shrubs commonly grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs.

This soil is suitable as a site for septic tank absorption fields and buildings. The slow absorption of liquid waste is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderate shrink-swell potential is a limitation on building sites, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIe.

15D—Buse-Svea loams, 1 to 15 percent slopes. These deep soils are on breaks to drainageways on till plains. The strongly sloping, well drained Buse soil is on the crest and shoulders of slopes, and the nearly level to moderately sloping, moderately well drained Svea soil is on the plane and concave lower side slopes. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. In some areas the soils are stony. Individual areas range from 15 to about 100 acres. They are about 55 percent Buse soil and 35 percent Svea soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Buse soil is very dark grayish brown loam about 7 inches thick. The upper part of the substratum is calcareous, light brownish gray and grayish brown loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled clay loam. In places the surface layer is less than 7 inches thick. In some areas between old glacial beaches, the soil contains less sand.

Typically, the surface soil of the Svea soil is black loam about 16 inches thick. The subsoil is very dark grayish brown clay loam about 10 inches thick. The substratum to a depth of about 60 inches is clay loam. It is calcareous and grayish brown in the upper part and is olive brown and mottled in the lower part. On some of the lower lying concave side slopes, the soil is somewhat poorly drained and has a calcareous layer within a depth of 16 inches. On some convex side slopes, it is well drained and has surface soil that is less than 16 inches thick. In some areas between old glacial beaches, it contains less sand.

Included with these soils in mapping are small areas of Cresbard, Lamoure, and Sioux soils. These included soils make up 1 to 10 percent of the unit. The moderately well drained, alkali Cresbard soils are on plane side slopes on till plains. The poorly drained Lamoure soils are on flood plains. The excessively drained Sioux soils are on the crest of ridges and knolls. They are shallow or very shallow over sand and gravel.

The Barnes and Svea soils are moderately slowly permeable. Available water capacity is high. Runoff is rapid on the Buse soil and slow on the Svea soil. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. The shrink-swell potential is moderate in both soils.

Most areas are used for pasture. A few areas are cultivated. These soils are unsuited to most cultivated crops and to hay because they are highly susceptible to soil blowing and water erosion and are nearly level to strongly sloping. A good cover of pasture plants or hay is effective in controlling soil blowing and water erosion. Timely deferment of grazing, proper stocking rates, and pasture rotation help to keep the pasture in good condition.

The Svea soil is suited to the commonly grown trees and shrubs, but the Buse soil generally is unsuited. Scalp-planted trees and shrubs can be established on the Buse soil, but optimum survival, growth, and vigor are unlikely. Few critical limitations affect trees and shrubs on the Svea soil. Measures that control soil blowing help to protect seedlings from abrasion.

The Svea soil is suitable as a site for buildings, but the Buse soil is poorly suited. The moderate shrink-swell potential and the slope are the main limitations. Also, the wetness of the Svea soil is a limitation on sites for dwellings with basements. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. Terraces help to control runoff, and subsurface drains help to prevent seepage into basements. The more nearly level areas should be selected as sites for buildings. Otherwise, the buildings should be designed to conform to the natural slope of the land. Land shaping is needed in some areas.

These soils are suitable as septic tank absorption fields. The slow absorption of liquid waste is a limitation, but it can be overcome by enlarging the field.

The capability subclass is VIe.

15E—Buse-Svea loams, 1 to 25 percent slopes. These deep soils are on breaks to drainageways on till plains and in areas between old glacial beaches. The strongly sloping and moderately steep, well drained Buse soil is on the crest and shoulders of slopes, and the nearly level to moderately sloping, moderately well drained Svea soil is on the plane and convex lower side slopes. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. In some areas the soils are stony. Individual areas range from 15 to more than 100 acres. They are about 60 percent Buse soil and 30 percent Svea soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Buse soil has a surface layer of very dark grayish brown loam about 7 inches thick. The upper part of the substratum is calcareous, light brownish gray and grayish brown loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled clay loam. In places the surface layer is less than 7 inches thick. In some areas between old glacial beaches, the soil contains less sand.

Typically, the surface soil of the Svea soil is black loam about 16 inches thick. The subsoil is very dark grayish brown clay loam about 10 inches thick. The substratum to a depth of about 60 inches is clay loam. It is calcareous and grayish brown in the upper part and is olive brown and mottled in the lower part. On some of the lower lying concave side slopes, the soil is somewhat poorly drained and has a calcareous layer within a depth of 16 inches. On some of the convex side slopes, it is well drained and has surface soil that is less than 16 inches thick. In some areas between old glacial beaches, it contains less sand.

Included with these soils in mapping are small areas of Cresbard, Kloten, Lamoure, and Sioux soils. These included soils make up 1 to 10 percent of the unit. The moderately well drained, alkali Cresbard soils are on the plane side slopes on till plains. The well drained Kloten soils are on convex shoulder slopes. They are very shallow or shallow over shale. The poorly drained Lamoure soils are on flood plains. The excessively drained Sioux soils are on the crest of slopes. They are very shallow or shallow over sand and gravel.

The Buse and Svea soils are moderately slowly permeable. Available water capacity is high. Runoff is very rapid on the Buse soil and slow on the Svea soil. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. The shrink-swell potential is moderate in both soils.

Most areas are used for pasture or support native hardwoods. A few areas are cultivated. These soils are unsuited to most cultivated crops and to hay because they are highly susceptible to soil blowing and water erosion and are nearly level to moderately steep. A good cover of pasture plants is effective in controlling soil blowing and water erosion. Timely deferment of grazing, proper stocking rates, and pasture rotation help to keep the pasture in good condition.

The Svea soil is suited to the commonly grown trees and shrubs, but the Buse soil generally is unsuited. Scalp-planted trees and shrubs can be established on the Buse soil, but optimum survival, growth, and vigor are unlikely. Few critical limitations affect trees and shrubs on the Svea soil. Measures that control soil blowing help to protect seedlings from abrasion.

The Svea soil is suitable as a site for buildings, but the Buse soil generally is unsuited because of the slope. The shrink-swell potential of the Svea soil is a limitation on all building sites. Also, the wetness of this soil is a limitation on sites for dwellings with basements. Because the steeper areas are unstable and are subject to slumping, the more nearly level areas should be selected as building sites. Otherwise, the buildings should be designed to conform to the natural slope of the land. Land shaping is needed in some areas. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. Terraces help to control runoff, and subsurface drains help to prevent seepage into basements.

The Svea soil is suitable as a septic tank absorption field, but the Buse soil generally is unsuitable because of the slope. The slow absorption of liquid waste in both soils is a limitation, but it can be overcome by enlarging the field.

The capability subclass is VIIe.

16—Lallie silty clay loam, ponded. This deep, level, very poorly drained, saline soil is in sloughs and intermittent lake basins on glacial lake plains. It is ponded for very long periods. The natural drainage pattern is poorly defined. Individual areas range from 40 to about 1,200 acres.

Typically, about 3 inches of black, partly decomposed organic material is at the surface. The surface layer is dark olive gray silty clay loam about 4 inches thick. The upper part of the substratum is dark olive gray, mottled, stratified silty clay loam. The next part is olive gray, mottled, stratified silty clay. The lower part to a depth of about 60 inches is dark gray, mottled silty clay. In places the soil is slightly saline. In some areas the substratum contains more sand. In other areas the soil is stony.

Included with this soil in mapping are small areas of Ojata soils, which make up 1 to 10 percent of the unit. These poorly drained soils are on the higher lying flats.

The Lallie soil is slowly permeable. Available water capacity is moderate. Runoff is ponded. A seasonal high water table is above or near the surface throughout the year. The shrink-swell potential is high. The soil is moderately saline to strongly saline.

Most areas of this soil are used for wetland wildlife habitat. The soil is suited to this kind of wildlife habitat. Because of the ponding, a lack of suitable drainage outlets, and the moderate salinity, it generally is unsuitable for most cultivated crops and for pasture, hay, and trees and shrubs.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the ponding. Also, the slow permeability is a limitation in septic tank absorption fields and the shrink-swell potential a limitation on building sites. Soils that are better suited to these uses generally are nearby.

The capability subclass is VIIIw.

17—Vang loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on delta plains and stream terraces. It is moderately deep over sand and gravel. Individual areas range from 5 to about 160 acres.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is very dark grayish brown, mottled clay loam about 12 inches thick. The upper part of the substratum is dark grayish brown sandy clay loam. The lower part to a depth of about 60 inches is very dark grayish brown very shaly coarse sand and coarse sand. In places the substratum has a lower content of shale. In a few areas, the surface layer is less than 10 inches thick and sand and gravel are within a depth of 20 inches.

Included with this soil in mapping are small areas of Sioux and Walsh soils, which make up 1 to 10 percent of the unit. The excessively drained Sioux soils are on the crest of knolls. They are shallow or very shallow over sand and gravel. The moderately well drained Walsh soils are deep over sand and gravel.

The Vang soil is moderately permeable in the upper part and rapidly permeable in the lower part. Available water capacity is moderate. Runoff is slow.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Droughtiness, which results from the moderate available water capacity, is a limitation during extended dry periods. Also, soil blowing is a hazard. Crop residue management and green manure crops conserve moisture. Field windbreaks, stripcropping, and buffer strips help to control soil blowing.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to the drought resistant trees and shrubs commonly grown as windbreaks and environmental plantings. Optimum survival, growth, and vigor, however, are not likely.

This soil is suitable as a site for septic tank absorption fields and buildings. It readily absorbs but does not adequately filter the liquid waste in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIs.

19—Hamerly loam, 1 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is on the low lying plane and slightly concave slopes on till plains. Individual areas range from 5 to about 100 acres.

Typically, the surface layer is black loam about 8 inches thick. The upper part of the substratum is calcareous, light brownish gray loam. The lower part to a depth of about 60 inches is olive, mottled loam. On the higher lying side slopes, the soil is moderately well drained and does not have a calcareous layer within a depth of 16 inches.

Included with this soil in mapping are small areas of Cresbard and Parnell soils and the moderately saline and nonsaline Vallers soils. These soils make up 1 to 10 percent of the unit. The moderately well drained, alkali Cresbard soils are on the higher lying side slopes. The very poorly drained Parnell soils are in depressions. They have a fine textured subsoil. The poorly drained Vallers soils are on the lower lying flats.

The Hamerly soil is moderately slowly permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 1.5 to 3 feet. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. The wetness caused by the seasonal high water table delays spring seeding in some years.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development. Wetness is the main limitation. Also, the moderately slow permeability is a limitation in septic tank absorption fields and the shrink-swell potential a limitation on building sites. Surface drains reduce the wetness, but the seasonal high water table is a continuing limitation. Subsurface drains help to prevent seepage into basements. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The slow absorption of liquid waste in septic tank absorption fields can be overcome by enlarging the field.

The capability subclass is IIe.

23—Cresbard-Cavour loams, 0 to 3 percent slopes. These deep, level and nearly level, moderately well drained, alkali soils are on till plains. The Cresbard soil is on the higher lying plane side slopes. The Cavour soil is on the lower plane and slightly convex side slopes.

Individual areas range from about 5 to several hundred acres. They are about 50 percent Cresbard soil and 30 percent Cavour soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Cresbard soil is loam about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is black clay loam about 12 inches thick. The upper part of the substratum is calcareous, dark grayish brown clay loam that is mottled below a depth of about 28 inches. The lower part to a depth of about 60 inches is grayish brown and dark grayish brown, mottled clay loam. In some cultivated areas plowing has mixed the upper part of the subsoil with the surface soil.

Typically, the surface layer of the Cavour soil is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is about 15 inches thick. It is black clay in the upper part and dark grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and grayish brown, mottled clay loam. In some of the lower lying areas in swales and on flats, the surface soil is less than 12 inches thick and visible salts are within a depth of 16 inches.

Included with these soils in mapping are small areas of Barnes, Buse, Hamerly, Parnell, and Svea soils, which make up 10 to 20 percent of the unit. These included soils do not have an alkali subsoil. Barnes soils are well drained and are on convex side slopes. Buse soils are well drained and are on the crest of knolls. They do not have a subsoil. Hamerly soils are somewhat poorly drained and are on the lower lying side slopes. They have a calcareous layer within a depth of 16 inches. Parnell soils are very poorly drained and are in depressions. Svea soils are on the lower concave side slopes.

Permeability is moderately slow in the Cresbard soil and slow in the Cavour soil. Available water capacity is moderate in both soils. Runoff is slow. The shrink-swell potential is high. The dense subsoil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The subsoil restricts root penetration, however, and moisture stress retards the growth of crops in most years. Planting green manure crops and returning crop residue to the soil increase the content of organic matter and thus improve tilth and soil structure. Including deep rooted legumes in the cropping sequence helps to loosen the dense subsoil. Tilling when the soil is wet increases the extent of surface crusting and clodding, both of which result in a poor seedbed.

A cover of pasture plants or hay improves tilth. Deep rooted legumes, such as alfalfa and sweetclover, help to loosen the dense subsoil. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The Cresbard soil is suited to many of the trees and shrubs commonly grown as windbreaks and environmental plantings. The Cavour soil generally is unsuited, however, because of the severe alkalinity and the restricted root zone.

These soils are suitable as sites for septic tank absorption fields and buildings. The slow absorption of liquid waste is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on sites for buildings, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIIs.

23B—Barnes-Cresbard loams, 1 to 6 percent slopes. These deep, nearly level and gently sloping soils are on till plains. The well drained Barnes soil is on convex side slopes and the crest of low knolls. The moderately well drained, alkali Cresbard soil is on the lower lying plane side slopes. In some areas the soils are stony. Individual areas range from 5 to about 100 acres. They are about 60 percent Barnes soil and 30 percent Cresbard soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is dark brown clay loam about 9 inches thick. The upper part of the substratum is calcareous, light olive brown clay loam about 9 inches thick. The lower part to a depth of about 60 inches is light olive brown, mottled clay loam. In places the surface layer is more than 7 inches thick. In some areas on the crest of knolls, the soil does not have a subsoil.

Typically, the Cresbard soil has a black loam surface layer about 8 inches thick. The subsoil is clay loam about 16 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The upper part of the substratum is calcareous, dark grayish brown clay loam that has segregated masses of gypsum crystals. The lower part to a depth of about 60 inches is light olive brown loam. In places the subsoil lacks strong columnar structure.

Included with these soils in mapping are small areas of Hamerly, Miranda, Parnell, and Sioux soils, which make up 1 to 10 percent of the unit. The somewhat poorly drained Hamerly soils are on the lower lying side slopes. They have a calcareous layer within a depth of 16 inches. The somewhat poorly drained, alkali Miranda soils have visible salts within a depth of 16 inches. Their surface soil is thinner than that of either the Barnes or the Cresbard soil. The very poorly drained Parnell soils are in depressions. The excessively drained Sioux soils are on the crest of knolls and ridges. They are shallow or very shallow over sand and gravel.

The Barnes and Cresbard soils are moderately slowly permeable. Available water capacity is high in the Barnes

soil and moderate in the Cresbard soil. Runoff is medium on both soils. The shrink-swell potential is high in the Cresbard soil and moderate in the Barnes soil. The dense subsoil of the Cresbard soil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. Water erosion on both soils and the high alkalinity and dense subsoil of the Cresbard soil are the main concerns of management. Also, moisture stress retards the growth of crops on the Cresbard soil. Grassed waterways and diversions help to control water erosion. Returning crop residue to the soil increases the infiltration rate and decreases the runoff rate. Planting green manure crops and returning crop residue to the soil increase the content of organic matter and thus improve tilth and soil structure. Including deep rooted legumes in the cropping sequence helps to loosen the subsoil of the Cresbard soil.

A cover of pasture plants or hay is effective in controlling water erosion and improving tilth. Deep rooted legumes, such as alfalfa and sweetclover, help to loosen the dense subsoil of the Cresbard soil. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to nearly all of the trees and shrubs commonly grown as windbreaks and environmental plantings.

These soils are suitable as sites for septic tank absorption fields and buildings. The slow absorption of liquid waste is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on sites for buildings, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIIe.

25—Overly silty clay loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on glacial lake plains. Individual areas range from 10 to about 400 acres.

Typically, the surface soil is black silty clay loam about 12 inches thick. The subsoil is very dark grayish brown silty clay loam about 11 inches thick. The upper part of the substratum is calcareous, dark grayish brown silt loam. The next part is calcareous, dark grayish brown, mottled silty clay loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled silty clay loam. In some places the surface soil is silt loam or silty clay. In other places the soil contains less clay. In some swales it is somewhat poorly drained and has a calcareous layer within a depth of 16 inches. On some swells and side slopes, the surface layer is less than 7 inches thick. In some areas adjacent to drainageways, the soil is gently sloping.

Included with this soil in mapping are small areas of the poorly drained Colvin and Perella soils in the deeper swales and depressions. These soils make up 1 to 10 percent of the unit.

The Overly soil is moderately slowly permeable. Available water capacity is high. Runoff is slow. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Returning crop residue to the soil and applying a proper kind and amount of fertilizer improve tilth and fertility and increase the content of organic matter.

This soil is suited to pasture and hay. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs.

This soil is suitable as a site for septic tank absorption fields and buildings. The shrink-swell potential is a limitation on sites for buildings, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The slow absorption of liquid waste is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The capability subclass is IIc.

26—Bearden-Overly silty clay loams, 0 to 3 percent slopes. These deep soils are on glacial lake plains. The level, somewhat poorly drained Bearden soil is on flats and in swales. The nearly level, moderately well drained Overly soil is on swells. Individual areas range from 5 to about 100 acres. They are about 65 percent Bearden soil and 30 percent Overly soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Bearden soil is black silty clay loam about 10 inches thick. The upper part of the substratum is calcareous, gray silty clay loam. The next part is light olive brown, mottled silt loam. The lower part to a depth of about 60 inches is grayish brown and light brownish gray, mottled silty clay loam. In places the surface layer is silt loam. In the deeper parts of some swales, the soil is poorly drained. In some areas it contains less clay.

Typically, the surface soil of the Overly soil is black silty clay loam about 12 inches thick. The subsoil is very dark grayish brown silty clay loam about 11 inches thick. The upper part of the substratum is calcareous, dark grayish brown silt loam. The next part is calcareous, dark grayish brown, mottled silty clay loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled silty clay loam. In some areas the surface soil is silt loam. In other areas it is less than 12 inches thick. In places the soil contains less clay. In some areas adjacent to drainageways, it is gently sloping.

Included with these soils in mapping are small areas of the poorly drained Perella soils in the deeper parts of

some depressions. These included soils make up 1 to 5 percent of the unit.

The Bearden and Overly soils are moderately slowly permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 1.5 to 2.5 feet in the Bearden soil. The shrink-swell potential is moderate in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, crop residue management, cover crops, stripcropping, and buffer strips. The wetness caused by the seasonal high water table in the Bearden soil delays spring seeding in some years. Surface drains improve the likelihood of timely tillage and seeding.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to most of the trees and shrubs commonly grown as windbreaks and environmental plantings. The species selected should be tolerant of the seasonal high water table in the Bearden soil. Measures that control soil blowing help to protect seedlings from abrasion.

The Overly soil is suitable as a site for septic tank absorption fields and buildings. The Bearden soil is poorly suited, however, because it is wet. Surface drains reduce the wetness, but the seasonal high water table is a continuing limitation. The shrink-swell potential of both soils is a limitation on building sites, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The slow absorption of liquid waste is a limitation if either of the soils is used as a septic tank absorption field, but it can be overcome by enlarging the field.

The capability subclass is IIe.

29—Velva sandy loam, 1 to 3 percent slopes. This deep, nearly level, well drained soil is on flood plains. It is flooded by stream overflow for short periods in some years. The flood plains generally are dissected into small, irregularly shaped areas by meandering channels and generally are isolated by deep channels or steep escarpments. Individual areas range from 5 to about 100 acres.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is black sandy loam about 8 inches thick. The upper part of the substratum is dark grayish brown sandy loam. The next part is very dark grayish brown fine sandy loam. The lower part to a depth of about 60 inches is stratified, dark grayish brown sandy loam and dark gray sand. In a few areas the surface layer and subsoil are loam or silt loam.

Included with this soil in mapping are small areas of Lamoure, Rauville, and Sioux soils, which make up 1 to 10 percent of the unit. The poorly drained Lamoure and very poorly drained Rauville soils are along drainageways. They contain more clay and less sand than the Velva soil. The excessively drained Sioux soils are on terraces and on point bars within meander belts. They do not have a subsoil.

The Velva soil is moderately rapidly permeable. Available water capacity is high. Runoff is slow.

Most areas support native hardwoods. Some areas have been cleared.

This soil is suited to small grain and sunflowers. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Occasionally, streams overflow in the spring, but the floodwater usually recedes in time for spring planting. Late seeded crops, such as flax or millet, can be seeded in years when the soil is flooded late in spring.

This soil is suited to pasture and hay. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the commonly grown trees and shrubs. Measures that control soil blowing help to protect seedlings from abrasion.

Because it is subject to flooding, this soil generally is unsuitable as a site for septic tank absorption fields and buildings. Dams and channels help to protect some areas from floodwater, but in most areas a less flood prone soil should be selected. Such soils generally are nearby.

The capability subclass is IIIe.

30—Walsh loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on delta plains. Individual areas range from 10 to about 500 acres.

Typically, the surface soil is black loam about 18 inches thick. The subsoil is loam about 22 inches thick. It is black in the upper part and dark brown and mottled in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown, mottled clay loam and silty clay loam. In places, the surface soil is silty clay loam and a layer in which lime has accumulated is in the upper part of the substratum. In some of the lower lying shallow swales, the soil is somewhat poorly drained. In some areas it is moderately deep over sand and gravel.

Included with this soil in mapping are small areas of Embden, Inkster, and Tiffany soils, which make up 1 to 10 percent of the unit. Embden and Inkster soils contain less clay than the Walsh soil. Tiffany soils are poorly drained and are in swales and depressions.

The Walsh soil is moderately permeable. Available water capacity is high. Runoff is medium. A seasonal high water table is at a depth of 4 to 6 feet. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and

potatoes. Returning crop residue to the soil and applying a proper kind and amount of fertilizer improve tilth and fertility and increase the organic matter content.

A cover of hay or pasture plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs.

This soil is suitable as a site for septic tank absorption fields and buildings. The shrink-swell potential is a limitation on all building sites, and the wetness is a limitation on sites for dwellings with basements. Also, the wetness and the moderate permeability are limitations in septic tank absorption fields. Subsurface drains help to prevent seepage into basements. Surface drains help to remove excess water. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the damage caused by shrinking and swelling. Enlarging septic tank absorption fields helps to overcome the slow absorption of liquid waste.

The capability subclass is IIc.

35—Rauville silt loam. This deep, level, very poorly drained soil is on bottom land and in seepy areas. It is frequently flooded for brief periods during spring runoff and heavy rainfall. The landscape generally is dissected into small, irregularly shaped areas by meandering channels, and many areas are isolated by deep channels or steep escarpments. Individual areas generally are long and narrow and range from 5 to about 100 acres.

Typically, about 2 inches of black, partly decomposed organic material is at the surface. The surface layer is black silt loam about 7 inches thick. The next 23 inches is very dark gray silty clay loam. The upper part of the substratum is dark gray silty clay loam. The lower part to a depth of about 60 inches is light brownish gray loamy sand. In places the soil is poorly drained. In some areas, the surface soil is thinner and a calcareous layer is within 16 inches of the surface. In other areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bearden and LaDelle soils, which make up 1 to 5 percent of the unit. Bearden soils are moderately saline and somewhat poorly drained. LaDelle soils are moderately well drained and are on the higher lying parts of flood plains.

The Rauville soil is moderately slowly permeable. Available water capacity is high. Runoff is very slow. A seasonal high water table is at or near the surface.

Most areas are idle or are used as wetland wildlife habitat. Much of the wetland wildlife habitat in the county is in areas of this soil.

This soil is unsuited to most cultivated crops and to pasture and hay because of excessive wetness. It generally is unsuited to trees and shrubs unless it is drained. The excessive wetness is a critical limitation affecting the survival, growth, and vigor of trees and shrubs.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the flooding and the wetness. Also, the moderately slow permeability is a limitation in septic tank absorption fields. Soils that are better suited to these uses generally are nearby.

The capability subclass is Vw.

39—Vallers-Manfred clay loams, saline. These deep, level soils are on low lying flats and along drainageways on till plains. They are ponded for brief periods during spring runoff and heavy rainfall. The poorly drained, moderately saline Vallers soil is on slightly concave and plane slopes. The very poorly drained, alkali Manfred soil is in the lower lying depressions and swales. In some areas the soils are stony. Individual areas range from 5 to about 50 acres. They are about 55 percent Vallers soil and 35 percent Manfred soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Vallers soil is black clay loam about 14 inches thick. It has masses of salt crystals. The upper part of the substratum is calcareous, gray and dark gray clay loam. The lower part to a depth of about 60 inches is gray, mottled clay loam. In some places the soil is somewhat poorly drained. In other places it is slightly saline or strongly saline. In some areas the surface layer is silty clay loam. In other areas the surface soil is more than 14 inches thick.

Typically, the surface layer of the Manfred soil is black clay loam about 8 inches thick. The subsoil is black clay loam about 6 inches thick. The upper part of the substratum is calcareous, dark grayish brown, mottled clay loam. The next part is grayish brown, mottled clay loam. The lower part to a depth of about 60 inches is gray, mottled loam. In places the surface layer is silty clay loam.

Included with these soils in mapping are small areas of Hamerly and Parnell soils and nonsaline Vallers soils. These included soils make up 1 to 10 percent of the unit. The somewhat poorly drained Hamerly soils are on the higher lying plane and slightly concave slopes. The very poorly drained Parnell soils are in depressions.

Permeability is moderately slow in the Vallers soil and slow in the Manfred soil. Available water capacity is moderate in both soils. Runoff is slow on the Vallers soil and ponded on the Manfred soil. A seasonal high water table is near or above the surface of both soils. The Vallers soil is slightly saline to strongly saline. The Manfred soil has a high shrink-swell potential. Its dense subsoil restricts the depth to which roots can penetrate.

Most areas are used for pasture or wildlife habitat or are idle. A few areas are cultivated along with adjacent areas where productivity is higher. These soils are suited to wetland wildlife habitat. They generally are unsuited to

small grain, sunflowers, pasture and hay, and windbreaks and environmental plantings because of excessive wetness, severe salinity and alkalinity, and susceptibility to soil blowing.

These soils generally are unsuitable as sites for septic tank absorption fields and buildings because of the ponding. Also, the slow or moderately slow permeability is a limitation in septic tank absorption fields and the shrink-swell potential of the Manfred soil a limitation on building sites. Soils that are better suited to these uses generally are nearby.

The capability subclass is Vw.

41—Bearden-Perella silty clays. These deep, level soils are on glacial lake plains. The somewhat poorly drained Bearden soil is on plane and slightly convex slopes. The poorly drained Perella soil is in depressions. It is subject to ponding. The natural drainage pattern is poorly defined, but excess surface water is removed from most areas by constructed drains. Individual areas range from about 10 to several hundred acres. They are about 55 percent Bearden soil and 35 percent Perella soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Bearden soil has a black silty clay surface layer about 9 inches thick. The upper part of the substratum is calcareous, dark grayish brown and brown, mottled silty clay loam. The next part is grayish brown, mottled silty clay loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled silty clay. On some swells the surface layer contains less clay. In some swales the soil is poorly drained. In places it is slightly saline.

Typically, the Perella soil has a black silty clay surface layer about 6 inches thick. The subsoil is silty clay loam about 14 inches thick. It is black in the upper part and very dark gray in the lower part. The substratum to a depth of about 60 inches is mottled silty clay loam. The upper part is calcareous and is dark grayish brown and grayish brown, the next part is grayish brown, and the lower part is gray. In some of the deeper depressions, the surface layer is more than 24 inches thick and the soil contains more clay throughout.

Included with these soils in mapping are small areas of the moderately saline Bearden soils and small areas of Wahpeton soils. These included soils make up 1 to 10 percent of the unit. Wahpeton soils are moderately well drained. Their surface soil is thicker than that of either the Bearden or the Perella soil, and the content of clay is higher.

The Bearden and Perella soils are moderately slowly permeable. Available water capacity is high. Runoff is slow on the Bearden soil and ponded on the Perella soil. A seasonal high water table is at a depth of 1.5 to 2.5 feet in the Bearden soil and is near or above the surface of the Perella soil. The shrink-swell potential is moderate in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. Wetness, poor tilth, and soil blowing are the main concerns of management. Surface drains improve the likelihood of timely tillage and seeding. Tilling the soils and keeping them in good tilth are difficult because of the high content of clay in the surface layer. Tilling at the proper moisture content helps to prevent surface compaction and the destruction of soil structure. Returning crop residue to the soil improves soil structure and helps to control soil blowing. Field windbreaks, stripcropping, and buffer strips also help to control soil blowing.

A cover of hay or pasture plants is effective in controlling soil blowing. Ponding interferes with haying in some years. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If drained, these soils are suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields and building site development. The ponding is the major limitation. Surface drains help to remove excess surface water, but the seasonal high water table is a continuing limitation. Subsurface drains help to prevent seepage into basements. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIw.

42—Nutley silty clay. This deep, level, well drained soil is on glacial lake plains. Individual areas range from 10 to about 100 acres.

Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is about 15 inches thick. It is very dark grayish brown silty clay in the upper part and dark grayish brown and very dark grayish brown, mottled clay in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay. In places, the soil is moderately well drained and the surface soil is more than 8 inches thick.

Included with this soil in mapping are small areas of the moderately well drained, alkali Aberdeen soils on the lower lying flats. These soils make up as much as 15 percent of the unit.

The Nutley soil is slowly permeable. Available water capacity is moderate. Runoff is medium. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Unfavorable soil structure and poor workability are the main limitations. Tilling the soil and keeping it in

good tilth are difficult because of the high content of clay. Tilling at the proper moisture content helps to prevent surface compaction and the destruction of soil structure. Returning crop residue to the soil improves soil structure and helps to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. Field windbreaks, stripcropping, buffer strips, and cover crops also help to control soil blowing.

A cover of hay or pasture plants is effective in controlling soil blowing and improving tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to many of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. The slow absorption of liquid waste is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell is a limitation on building sites, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIs.

43B—Cashel silty clay loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, somewhat poorly drained soil is on flood plains. It is occasionally flooded by stream overflow. The flood plains are 200 to about 4,000 feet wide and are generally dissected into small, irregularly shaped areas by meandering channels. Many areas are isolated by deep channels and steep escarpments. Individual areas range from 5 to about 1,000 acres.

Typically, the surface layer is very dark gray silty clay loam about 9 inches thick. The upper part of the substratum is very dark gray, finely stratified silty clay loam. The next part is black silty clay loam. The lower part to a depth of about 60 inches is very dark gray, mottled silty clay loam. In places the surface layer is silty clay.

Included with this soil in mapping are small areas of Bearden, Dovray, LaDelle, and Wahpeton soils. These soils make up 1 to 10 percent of the unit. Their surface soil is thicker than that of the Cashel soil. The somewhat poorly drained, moderately saline Bearden soils are along road ditches and drainageways. The poorly drained Dovray soils are in oxbows. The moderately well drained LaDelle and Wahpeton soils are on the higher lying, less frequently flooded terraces.

The Cashel soil is moderately slowly permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 1 to 3 feet. The shrink-swell potential is high.

Most areas are used for cultivated crops. Some support native hardwoods. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Flooding is the main hazard. Streams occasionally overflow in the spring, but the floodwater usually recedes in time for spring planting. Late seeded crops, such as flax or millet, can be seeded in years when the soil is flooded late in spring. Occasionally, crops are damaged by floodwater during the growing season. Soil blowing is a hazard if cultivated crops are grown. It can be controlled by stripcropping, crop residue management, cover crops, and buffer strips.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the commonly grown trees and shrubs. No critical limitations affect the trees and shrubs. The areas that support native hardwoods make up a large part of the woodland wildlife habitat in the county.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the flooding. Soils that are not subject to flooding are better sites for these uses.

The capability subclass is IIw.

43E—Cashel silty clay loam, 6 to 25 percent slopes. This deep, moderately sloping to moderately steep, somewhat poorly drained soil is on channeled bottom land. It is occasionally flooded by stream overflow. The bottom land is 200 to about 1,000 feet wide and is dissected into small, irregularly shaped areas by meandering channels. It generally is isolated by deep channels and steep escarpments. Individual areas range from 5 to about 100 acres.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. The substratum to a depth of about 60 inches is multicolored, finely stratified silty clay loam. In places the surface layer is silty clay.

Included with this soil in mapping are small areas of Dovray, LaDelle, and Wahpeton soils. These soils make up 5 to 15 percent of the unit. Their surface soil is more than 24 inches thick. The poorly drained Dovray soils are in oxbows. The moderately well drained LaDelle and Wahpeton soils are on the higher lying, less frequently flooded stream terraces.

The Cashel soil is moderately slowly permeable. Available water capacity is high. Runoff is medium. A seasonal high water table is at a depth of 1 to 3 feet. The shrink-swell potential is high.

Most areas support native hardwoods. This soil is unsuited to most cultivated crops and to pasture and hay because of a moderately high susceptibility to erosion, the slope, and the flooding. Most areas cannot be used for crops or pasture because they are isolated by deep channels or are too irregularly shaped.

This soil is suited to all of the commonly grown trees and shrubs. No critical limitations affect the trees and shrubs. The areas that support native trees and shrubs

make up a large part of the woodland wildlife habitat in the county.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the flooding. Soils that are not subject to flooding generally are nearby.

The capability subclass is VIe.

45—Wahpeton silty clay, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on flood plains. It is occasionally flooded by stream overflow. Some areas are isolated by deep channels and steep escarpments. Individual areas range from 10 to more than 600 acres.

Typically, the surface soil is black silty clay about 29 inches thick. The upper part of the substratum is very dark grayish brown silty clay. The lower part to a depth of about 60 inches is dark grayish brown, mottled silty clay loam. In some places the surface layer is clay. In other places the surface soil is less than 24 inches thick. In a few areas the soil contains less clay.

Included with this soil in mapping are small areas of Cashel and Perella soils. These soils make up 1 to 15 percent of the unit. They contain less clay than the Wahpeton soil. The somewhat poorly drained Cashel soils are on the lower lying, more frequently flooded bottom land. The poorly drained Perella soils are in depressions.

The Wahpeton soil is moderately slowly permeable. Available water capacity is high. Runoff is medium. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Unfavorable soil structure and poor workability are the chief limitations. Tilling the soil and keeping it in good tilth are difficult because of the high content of clay. Tilling at the proper moisture content helps to prevent surface compaction and the destruction of soil structure. Returning crop residue to the soil improves soil structure and helps to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. Field windbreaks, stripcropping, buffer strips, and cover crops also help to control soil blowing. Streams occasionally overflow in the spring, but the floodwater usually recedes in time for spring planting. Occasionally, crops are damaged by floodwater during the growing season.

A cover of hay or pasture plants is effective in controlling soil blowing and improving tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the commonly grown trees and shrubs. Measures that control soil blowing help to protect seedlings from abrasion.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the flooding. Soils that are not subject to flooding are better sites for these uses.

The capability subclass is IIs.

46—LaDelle silt loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flood plains and stream terraces. It is occasionally flooded by stream overflow for brief periods. The flood plains generally are dissected into small, irregularly shaped areas by meandering channels and commonly are isolated by deep channels or steep escarpments. Individual areas range from 5 to about 600 acres.

Typically, the surface soil is black silt loam about 34 inches thick. The upper part of the substratum is dark grayish brown and dark gray, mottled silty clay loam. The lower part to a depth of about 60 inches is black silty clay loam. In some places the surface soil is loam or silty clay loam. In other places it is less than 34 inches thick. In some areas, the surface soil is sandy loam and the soil contains less clay and more sand throughout.

Included with this soil in mapping are small areas of the poorly drained Lamoure and very poorly drained Rauville soils. These soils make up as much as 10 percent of the unit. They are in the lower lying areas along drainageways.

The LaDelle soil is moderately permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet.

Most areas are cultivated. Some support native hardwoods. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Returning crop residue to the soil and applying a proper kind and amount of fertilizer improve tilth and fertility and increase the organic matter content. Streams occasionally overflow in the spring, but the floodwater usually recedes in time for spring planting. Late seeded crops, such as flax or millet, can be seeded in years when the soil is flooded late in spring.

This soil is suited to pasture and hay. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the commonly grown trees and shrubs. No critical limitations affect the trees and shrubs.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings because of the occasional flooding. Soils that are not subject to flooding are better sites for these uses.

The capability subclass is IIc.

48—Wyndmere sandy loam. This deep, level, somewhat poorly drained soil is on broad flats on delta plains and in the lower lying slightly convex areas on beaches. Individual areas range from 5 to about 150 acres.

Typically, the surface layer is black sandy loam about 10 inches thick. The upper part of the substratum is calcareous, gray and grayish brown sandy loam. The next part is brown loamy fine sand. The lower part to a depth of about 60 inches is pale brown, mottled fine sand. In places the surface layer is loam. On some

swells the soil is moderately well drained and does not have a calcareous layer within a depth of 16 inches. In some areas it contains less sand. In some swales the calcareous layer is more than 16 inches below the surface.

Included with this soil in mapping are small areas of the poorly drained Arveson, Hamar, and Tiffany soils. These soils make up 1 to 15 percent of the unit. They are in depressions, swales, and seepy areas. The Hamar and Tiffany soils do not have a calcareous layer within a depth of 16 inches.

The Wyndmere soil is moderately rapidly permeable. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 2 to 5 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Wetness delays seeding in some years.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development. The wetness is the main limitation. A drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

50B—Hecla fine sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, moderately well drained soil is on plane and slightly concave slopes on delta plains and beaches. Individual areas range from 10 to about 600 acres.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The next 9 inches is very dark grayish brown fine sandy loam. The upper part of the substratum is yellowish brown, mottled fine sand. The next part is dark brown loamy sand. The lower part to a depth of about 60 inches is dark grayish brown fine sand. In places the surface layer is loamy fine sand or sandy loam. On some of the crests and shoulders of knolls and ridges, it is less than 8 inches thick. In some areas the substratum contains slightly more clay and less sand. In other areas it is coarser textured.

Included with this soil in mapping are small areas of the poorly drained Arveson and Hamar soils. These soils make up 1 to 10 percent of the unit. They are in shallow swales and seepy areas. The Arveson soils have a calcareous layer within a depth of 16 inches.

The Hecla soil is rapidly permeable. Available water capacity is low. Runoff is slow. A seasonal high water table is at a depth of 3 to 6 feet.

Most areas are used for cultivated crops and pasture. This soil is suited to small grain and sunflowers. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, crop residue management, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Droughtiness, a result of the low available water capacity, is a concern of management, especially during extended dry periods. Crop residue management and green manure crops conserve soil moisture.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the commonly grown trees and shrubs. Survival, growth, and vigor are reduced during some dry periods because the soil is droughty. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. In some years the seasonal high water table interferes with the functioning of septic tank absorption fields. Also, it is a limitation on sites for dwellings with basements. A drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements. Because of the rapid permeability, the soil does not adequately filter the effluent in the absorption fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

51B—Hecla-Maddock fine sandy loams, 1 to 6 percent slopes. These deep soils are on delta plains and beaches. The nearly level, moderately well drained Hecla soil is on plane and slightly concave slopes. The gently sloping, well drained Maddock soil is on the crest and shoulders of closely spaced low ridges and knolls. Individual areas range from 10 to about 600 acres. They are about 55 percent Hecla soil and 35 percent Maddock soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Hecla soil has a black fine sandy loam surface layer about 8 inches thick. The next 9 inches is very dark grayish brown fine sandy loam. The upper part of the substratum is yellowish brown, mottled fine sand. The next part is dark brown loamy sand. The lower part to a depth of about 60 inches is dark grayish brown fine sand. In some areas the surface layer is loamy fine sand or sandy loam. In other areas coarser sand is in the substratum. In places the soil is gently sloping.

Typically, the Maddock soil has a very dark gray fine sandy loam surface layer about 9 inches thick. The next

5 inches is very dark grayish brown loamy sand. The substratum to a depth of about 60 inches is fine sand. It is dark brown in the upper part, brown in the next part, and grayish brown in the lower part. In some areas the surface layer is loamy fine sand or sandy loam. In other areas the soil contains coarser sand and gravel. In places it is moderately sloping.

Included with these soils in mapping are small areas of the poorly drained Arveson and Hamar soils. These included soils make up 5 to 15 percent of the unit. They are in the deeper swales and in seepy areas. The Arveson soils have a calcareous layer within a depth of 16 inches.

The Hecla and Maddock soils are rapidly permeable. Available water capacity is low. Runoff is slow. A seasonal high water table is at a depth of 3 to 6 feet in the Hecla soil.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Droughtiness, a result of the low available water capacity, is a concern of management, especially during extended dry periods. Crop residue management and green manure crops conserve soil moisture.

These soils are suited to hay and pasture. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The Hecla soil is suited to all of the commonly grown trees and shrubs. The Maddock soil is suited to only some species. Survival and growth rates and vigor are reduced during dry periods because the soils are droughty. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. Septic tank absorption fields function well in the Maddock soil. In some years, however, they do not function well in the Hecla soil because of the seasonal high water table. A drainage system reduces the wetness in the absorption fields and helps to prevent seepage into basements of the dwellings built on the Hecla soil. Because of the rapid permeability, these soils do not adequately filter the effluent in the absorption fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

51E—Maddock sandy loam, 9 to 25 percent slopes. This deep, strongly sloping and moderately steep, well drained soil is on convex slopes along drainageways on delta plains and in areas between old glacial beaches. Short, steep escarpments abruptly terminate slopes in some areas. Individual areas range from 5 to about 160 acres.

Typically, the surface layer is very dark gray sandy loam about 5 inches thick. The next 9 inches is dark gray sandy loam. The upper part of the substratum is dark grayish brown loamy fine sand. The lower part to a depth of about 60 inches is multicolored, stratified fine sand. In places the surface layer is loamy fine sand. On some of the plane and slightly concave slopes, the soil is moderately well drained and the surface soil is more than 5 inches thick.

Included with this soil in mapping are small areas of Embden and Sioux soils, which make up 1 to 10 percent of the unit. The moderately well drained Embden soils are on the lower lying plane and concave slopes. They have a subsoil, and their surface layer is thicker than that of the Maddock soil. The excessively drained Sioux soils are on the crest and shoulders of slopes. They are very shallow or shallow over sand and gravel.

The Maddock soil is rapidly permeable. Available water capacity is low. Runoff is slow.

Most areas are used as wooded pasture or are idle. A few areas are used for cultivated crops or pasture. Because of a high susceptibility to soil blowing, the slope, and the droughtiness, this soil generally is unsuited to cultivated crops. It is suited to pasture and to openland wildlife habitat. Proper stocking rates, timely deferment of grazing, and pasture rotation help to keep the pasture in good condition.

This soil generally is unsuited to most of the trees and shrubs commonly grown as windbreaks and environmental plantings because it is droughty and strongly sloping and moderately steep. Scalp-planted trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. The buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping is needed in some areas. The sides of shallow excavations tend to cave in unless they are shored. Because of the rapid permeability, the soil does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. The slope is a limitation on sites for the absorption fields, but it can be overcome by land shaping and by installing the distribution lines across the slope.

The capability subclass is VIe.

53—Hamar sandy loam. This deep, level, poorly drained soil is on broad flats and in swales on delta plains and in seepy areas on beaches. The natural drainage pattern is poorly defined. Excess surface water collects in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from about 5 to 150 acres.

Typically, the surface soil is black sandy loam about 11 inches thick. It is mottled in the lower part. The next 6

inches is very dark gray, mottled loamy sand. The substratum to a depth of about 60 inches is mottled loamy sand. It is dark gray in the upper part and grayish brown in the lower part. In places the substratum contains more clay. In some areas the surface soil is loamy fine sand. In other areas the soil is calcareous throughout.

Included with this soil in mapping are small areas of the moderately well drained Hecla and somewhat poorly drained Wyndmere soils on the higher lying slopes. These soils make up 5 to 10 percent of the unit. The Wyndmere soils have a calcareous layer within a depth of 16 inches.

The Hamar soil is rapidly permeable. Available water capacity is low. Runoff is slow. A seasonal high water table is at or near the surface.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. In wet years it is suitable for the crops seeded late in the growing season. Wetness and a high susceptibility to soil blowing are the main concerns of management. Deep seepage, natural runoff, or constructed drains remove excess surface water from most areas. Field windbreaks, crop residue management, stripcropping, cover crops, and buffer strips help to control soil blowing.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition. The wetness hinders haying in some years.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Selecting species that are tolerant of a seasonal high water table helps to obtain maximum growth and vigor.

This soil is poorly suited to septic tank absorption fields and building site development. The wetness is the main limitation. It can be reduced by installing a drainage system, but the seasonal high water table is a continuing limitation. Because of the rapid permeability, the soil does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Soils that are better suited to building site development and septic tank absorption fields generally are near this soil.

The capability subclass is IIIw.

54B—Embden fine sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, moderately well drained soil is on delta plains and beaches. Individual areas range from 5 to about 3,200 acres.

Typically, the surface layer is black fine sandy loam about 11 inches thick. The subsoil is very dark gray fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is fine sandy loam. It is dark brown in the upper part and dark grayish brown in the lower part. In places the surface layer is loam. On some of the convex side slopes and crests of knolls and ridges, it is less than 11 inches thick. In some of the lower lying swales and seepy areas, a calcareous layer is within a depth of 16 inches. In some areas the lower part of the substratum is stratified sand. In other areas the soil contains more clay.

Included with this soil in mapping are small areas of the poorly drained Arveson and Tiffany soils, which make up 1 to 10 percent of the unit. These soils are in swales and seepy areas. The Arveson soils have a calcareous layer within a depth of 16 inches.

The Embden soil is moderately rapidly permeable. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 3.5 to 6 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Droughtiness, a result of the moderate available water capacity, is a limitation during extended dry periods. Crop residue management and green manure crops conserve soil moisture.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. The wetness is the main limitation. Installing a drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIe.

55—Tiffany loam. This deep, level, poorly drained soil is in depressions, in swales, and on flats on delta plains and in seepy areas between old glacial beaches. The natural drainage pattern is poorly defined. Excess surface water occasionally ponds in the lower lying areas for long periods during spring runoff and heavy rainfall. Individual areas range from 10 to about 150 acres.

Typically, the surface layer is black loam about 9 inches thick. The next 4 inches is black clay loam. The subsoil is sandy clay loam about 13 inches thick. It is very dark gray and mottled in the upper part and calcareous and very dark grayish brown in the lower part. The upper part of the substratum is calcareous, dark gray, mottled sandy loam. The next part is calcareous, gray, mottled sandy clay loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled fine sandy loam. In places the soil is somewhat poorly drained. In some areas it contains less clay. In other areas the surface soil is sandy loam.

Included with this soil in mapping are small areas of Embden, Inkster, Walsh, and Wyndmere soils, which make up 1 to 15 percent of the unit. The moderately well drained Embden, Inkster, and Walsh soils are in the higher lying areas. The Embden and Inkster soils contain less clay than the Tiffany soils, and the Walsh soils contain less sand and more clay. The somewhat poorly drained Wyndmere soils contain less clay and have a calcareous layer within a depth of 16 inches.

The Tiffany soil is moderately permeable. Available water capacity is moderate. Runoff is ponded. A seasonal high water table is above the surface or within a depth of 3 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, and potatoes if the excess surface water is removed. It is suited to late seeded crops in most years, but the seasonal ponding is a problem. The water is removed from most areas by natural runoff, deep seepage, or constructed drains.

This soil is suited to pasture and hay. Ponding hinders haying in some years. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Selecting species that are tolerant of a seasonal high water table helps to obtain maximum growth and vigor.

This soil is poorly suited to septic tank absorption fields and building site development because of the ponding. Better drained soils generally are nearby.

The capability subclass is IIw.

59—Towner fine sandy loam, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on flats and slightly concave slopes on beaches. Individual areas range from 5 to about 150 acres.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsurface layer is about 10 inches thick. It is black fine sandy loam in the upper part and very dark brown loamy fine sand in the lower part. The upper part of the substratum is dark grayish brown, mottled fine sand. The next part is olive brown, mottled fine sand. The lower part to a depth of about 60 inches is multicolored silty clay loam. In some places the surface layer is loamy sand. In other places the upper part of the substratum contains more clay. On some of the crests of ridges and knolls, the soil is well drained and the surface soil is less than 18 inches thick. In some areas the soil is deep over till.

Included with this soil in mapping are small areas of Svea soils, which make up 1 to 10 percent of the unit. These soils contain more clay in the upper part than the Towner soil.

The Towner soil is rapidly permeable in the upper part and moderately slowly permeable in the lower part. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 3 to 6 feet. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Droughtiness, a result of the moderate available water capacity, is a limitation during extended dry periods. Crop residue management and green manure crops conserve soil moisture.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a septic tank absorption field. The seasonal wetness is a limitation, but it can be reduced by installing a subsurface drainage system. The rapid permeability in the upper part of the soil and the moderately slow permeability in the lower part also are limitations. The slow absorption of liquid waste can be overcome by enlarging the field. Because it is rapidly permeable in the upper part, however, the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water.

This soil is suitable as a site for buildings. The seasonal wetness and the shrink-swell potential are limitations on sites for dwellings with basements. A subsurface drainage system helps to prevent seepage into basements. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

60—Grimstad fine sandy loam. This deep, level, somewhat poorly drained soil is on broad flats, in shallow swales, and in seepy areas between old glacial beaches. It is stony in some areas. Individual areas range from 5 to about 200 acres.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The upper part of the substratum is calcareous, dark gray, mottled fine sandy loam about 11 inches thick. The next part is brown loamy fine sand. The lower part to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the surface layer is sandy loam. In other places the upper part of the substratum contains more clay. In some shallow depressions and swales, the soil is poorly drained, and in some it does not have a calcareous layer within a depth of 16 inches. On some of the higher lying swells and beaches, it is moderately well drained and does not have a calcareous layer within a depth of 16 inches.

Included with this soil in mapping are small areas of the poorly drained Arveson soils, which make up 1 to 5 percent of the unit. These soils are in swales and in seepy areas. They contain more clay in the upper part of the substratum than the Grimstad soil and do not have a contrasting layer of clay loam in the lower part.

The Grimstad soil is rapidly permeable in the upper part and moderately permeable in the lower part. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 2.5 to 6 feet.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is susceptible to soil blowing, however, if cultivated crops are grown. Field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing and conserve soil moisture. Soil blowing on fall tilled fields can be controlled by leaving crop residue on the surface throughout the winter. Wetness delays seeding in some years. In some areas stones interfere with fieldwork.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. Wetness is a limitation in septic tank absorption fields and on sites for dwellings with basements. A drainage system removes excess surface water and reduces the wetness in the absorption fields. A subsurface drainage system helps to prevent seepage into basements. Because it is rapidly permeable in the upper part, the soil does not adequately filter the effluent in the absorption fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

62—Rockwell fine sandy loam. This deep, level, poorly drained soil is on broad flats and in seepy areas between old glacial beaches. It is stony in some areas. The natural drainage pattern is poorly defined. Excess surface water ponds in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from 5 to about 50 acres.

Typically, the surface layer is black fine sandy loam about 9 inches thick. The upper part of the substratum is calcareous, dark grayish brown, mottled fine sandy loam. The next part is dark grayish brown, mottled fine sand. The lower part to a depth of about 60 inches is gray, mottled loam. In places the surface layer is loam. In some areas the soil does not have a calcareous layer within a depth of 16 inches. On some slight swells it is somewhat poorly drained. On other swells the upper part of the substratum contains more clay.

Included with this soil in mapping are small areas of Arveson and Towner soils, which make up 1 to 10 percent of the unit. The poorly drained Arveson soils contain more clay in the upper part of the substratum than the Rockwell soil and do not have a constrasting layer of loam in the lower part. The moderately well drained Towner soils are on the higher lying swells and ridges.

The Rockwell soil is moderately permeable. Available water capacity is moderate. Runoff is ponded. A seasonal high water table is above the surface or within a depth of 3 feet.

Most areas are used for cultivated crops or for pasture or hay. This soil is suited to small grain and sunflowers. It is suitable for late seeded crops in most years, but the seasonal ponding is a problem. Wetness and a high susceptibility to soil blowing are the main concerns of management. Excess surface water is removed from most areas by natural runoff, deep seepage, or constructed drains. Field windbreaks, crop residue management, stripcropping, cover crops, and buffer strips help to control soil blowing. In some areas stones interfere with fieldwork.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition. Ponding hinders haying in some years.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development because of the ponding. Better suited soils should be selected as sites for these uses.

The capability subclass is IIIw.

64—Antler silt loam. This deep, level, somewhat poorly drained soil is on broad flats in areas between old glacial beaches. Individual areas range from 10 to about 900 acres.

Typically, the surface layer is black silt loam about 9 inches thick. The upper part of the substratum is calcareous, gray silt loam. The next part is calcareous, light olive brown silty clay loam. The lower part to a depth of about 60 inches is light olive brown, mottled loam and clay loam. In places the soil contains less clay in the upper part. In some areas it is moderately well drained and has a calcareous layer below a depth of 16 inches. In some shallow depressions and swales, it has a mottled subsoil and does not have a calcareous layer within a depth of 16 inches. In a few places some stones are on the surface.

Included with this soil in mapping are small areas of the moderately saline Antler soils and small areas of Parnell and Tonka soils. These soils make up 1 to 15 percent of the unit. The moderately saline Antler soils

are in isolated areas and along road ditches and field drains. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. They have a fine textured subsoil.

The Antler soil is moderately slowly permeable. Available water capacity is high. Runoff is very slow. The soil is nonsaline or slightly saline. A seasonal high water table is at a depth of 1 to 4 feet.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. The wetness caused by the seasonal high water table delays spring seeding and limits crop growth in some years. In some areas stones interfere with fieldwork.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development. The wetness is the main limitation. Also, the moderately slow permeability is a limitation in septic tank absorption fields. Surface drains reduce the wetness, but the seasonal high water table is a continuing limitation. Subsurface drains help to prevent seepage into basements. The slow absorption of liquid waste in septic tank absorption fields can be overcome by enlarging the field.

The capability subclass is IIe.

65—Antler silty clay loam, saline. This deep, level, somewhat poorly drained, moderately saline soil is on broad flats in areas between old glacial beaches. It is stony in some areas. Individual areas range from 5 to several thousand acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. It contains salt crystals. The upper part of the substratum is calcareous, brownish gray silty clay loam. The next part is light olive brown fine sandy loam. The lower part to a depth of about 60 inches is olive brown, mottled clay loam. In some places the upper 18 inches contains less clay. In other places the surface layer is clay loam or loam. In some depressions and swales, the soil does not have a calcareous layer within a depth of 16 inches. In some areas it is poorly drained. In other areas it is slightly saline or strongly saline.

Included with this soil in mapping are small areas of the very strongly saline Ojata soils and the nonsaline Antler, Parnell, and Tonka soils. These soils make up 1 to 15 percent of the unit. The poorly drained Ojata soils are in the lower lying swales or sloughs. The very poorly drained Parnell and poorly drained Tonka soils are in depressions.

The Antler soil is moderately slowly permeable. Available water capacity is moderate. Runoff is very slow. A seasonal high water table is at a depth of 1 to 4 feet.

Most areas are used for cultivated crops or for pasture or hay. This soil is suited to small grain and sunflowers. Salinity is the main limitation affecting the survival, vigor, and growth of most cultivated crops. Also, soil blowing is a hazard. Moderately salt tolerant crops, such as barley, rye, oats, and wheat, can be grown. Once established, alfalfa also is moderately salt tolerant, but the seedlings exhibit low tolerance. Field windbreaks, stripcropping, buffer strips, and cover crops help to control soil blowing. In some areas stones interfere with fieldwork. Wetness delays seeding in some years.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is unsuited to most of the trees and shrubs commonly grown as windbreaks and environmental plantings. Only the most salt tolerant species can be grown.

This soil is poorly suited to septic tank absorption fields and building site development. The wetness is the main limitation. Also, the moderately slow permeability is a limitation in septic tank absorption fields. Surface drains reduce the wetness, but the seasonal high water table is a continuing limitation. Subsurface drains help to prevent seepage into basements. The slow absorption of liquid waste in septic tank absorption fields can be overcome by enlarging the field.

The capability subclass is IIIs.

67—Gilby loam. This deep, level, somewhat poorly drained soil is on broad flats in areas between old glacial beaches. It is stony in some areas. Individual areas range from 10 to about 400 acres.

Typically, the surface soil is black loam about 12 inches thick. The upper part of the substratum is calcareous, grayish brown, mottled silt loam. The next part is light olive brown, mottled loam. The lower part to a depth of about 60 inches is gray and olive brown, mottled clay loam. In places the soil contains more clay in the upper part. In some slight depressions the calcareous layer is more than 16 inches below the surface. On some of the lower lying flats and in seepy areas, the soil is poorly drained. On some swells it is moderately well drained and has a calcareous layer below a depth of 16 inches.

Included with this soil in mapping are small areas of the moderately saline Antler soils and small areas of Grimstad and Parnell soils. These soils make up 5 to 15 percent of the unit. Antler soils are on flats and along road ditches and field drains. Grimstad soils contain less clay than the Gilby soil. Parnell soils are very poorly

drained and are in the deeper depressions. They have a fine textured subsoil.

The Gilby soil is moderately slowly permeable. Available water capacity is high. Runoff is very slow. A seasonal high water table is at a depth of 1 to 4 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. In some areas stones interfere with fieldwork. The wetness caused by the seasonal high water table delays seeding in some years.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development. The wetness is the main limitation. Also, the moderately slow permeability is a limitation in septic tank absorption fields. Surface drains reduce the wetness, but the seasonal high water table is a continuing limitation. Subsurface drains help to prevent seepage into basements. The slow absorption of liquid waste in septic tank absorption fields can be overcome by enlarging the field.

The capability subclass is IIe.

70—Antler-Tonka silty clay loams, saline. These deep, level soils are on broad flats in areas between old glacial beaches. The flats are pitted with depressions. The somewhat poorly drained, moderately saline Antler soil is on the flats, and the poorly drained Tonka soil is in the depressions. The natural drainage pattern is poorly defined. Excess surface water frequently ponds in undrained depressions for long periods during spring runoff and heavy rainfall. Individual areas range from 10 to about 500 acres. They are about 55 percent Antler soil and 35 percent Tonka soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Antler soil has a black silty clay loam surface layer about 7 inches thick. It contains salt crystals. The substratum to a depth of about 60 inches is, in sequence downward, calcareous, very dark gray silty clay loam that contains salt crystals; calcareous, grayish brown silty clay loam; calcareous, light olive gray, mottled silty clay loam; and dark grayish brown clay loam. In some places the upper 18 inches contains less clay. In other places the surface layer is loam or clay loam. In some areas the soil is slightly saline or strongly saline. In other areas it is poorly drained. In places it is stony.

Typically, the Tonka soil has a black silty clay loam surface layer about 7 inches thick. The subsurface layer is very dark gray silty clay loam about 4 inches thick. The subsoil is about 12 inches thick. It is very dark gray silty clay loam in the upper part and olive gray, mottled silty clay in the lower part. The substratum to a depth of about 60 inches is mottled silty clay loam. It is pale olive in the upper part and olive in the lower part. In places the surface layer is silt loam or loam. In some areas the soil does not have a subsurface layer.

Included with these soils in mapping are small areas of the nonsaline Antler, Gilby, and Parnell soils, which make up 1 to 15 percent of the unit. Gilby soils contain less clay in the upper 18 inches than the Antler and Tonka soils. The very poorly drained Parnell soils are in depressions.

Permeability is moderately slow in the Antler soil and slow in the Tonka soil. Available water capacity is moderate in the Antler soil and high in the Tonka soil. Runoff is very slow on the Antler soil and is ponded on the Tonka soil. The shrink-swell potential is high in the Tonka soil. A seasonal high water table is at a depth of 1 to 4 feet in the Antler soil and is above or near the surface of the Tonka soil.

Most areas are used for pasture, hay, or cultivated crops. These soils are suited to small grain and sunflowers if the excess surface water is removed. The ponding and the salinity are the main limitations. Also, soil blowing is a hazard. Surface drains improve the likelihood of timely tillage and seeding. The moderate salinity of the Antler soil affects the survival, vigor, and growth of most cultivated crops. Moderately salt tolerant crops, such as barley, rye, oats, and wheat, can be grown. Once established, alfalfa also is moderately salt tolerant, but the seedlings exhibit low tolerance. Field windbreaks, stripcropping, and annual buffer strips help to control soil blowing.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The Antler soil is unsuited to most of the trees and shrubs commonly grown as windbreaks and environmental plantings. Only the most salt tolerant species can be grown. If drained, the Tonka soil is suited to all of the commonly grown trees and shrubs. Measures that control soil blowing help to protect seedlings from abrasion.

The Antler soil is poorly suited and the Tonka soil generally unsuited to septic tank absorption fields and building site development. The ponding on the Tonka soil and the wetness of the Antler soil are the main limitations. Because of the ponding, the Tonka soil generally is not used as a site for buildings or septic tank absorption fields. Installing a drainage system in the Antler soil reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements. The seasonal high water table, however, is a continuing

limitation. The moderately slow permeability of the Antler soil is a limitation in the absorption fields. It can be overcome, however, by enlarging the field.

The capability subclass is IIIw.

71—Hamerly-Tonka complex, 0 to 3 percent slopes. These deep soils are on till plains. The nearly level, somewhat poorly drained Hamerly soil is on low rises and in shallow swales, and the level, poorly drained Tonka soil is in depressions. The natural drainage pattern is poorly defined. Excess surface water frequently ponds in the depressions during periods of spring runoff and heavy rainfall. Individual areas range from 10 to about 350 acres. They are about 50 percent Hamerly soil and 40 percent Tonka soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a black loam surface layer about 8 inches thick. The upper part of the substratum is calcareous, light brownish gray loam. The lower part to a depth of about 60 inches is olive, mottled loam. In some of the higher lying areas, the soil is moderately well drained, has a subsoil, and does not have a calcareous layer within a depth of 16 inches.

Typically, the Tonka soil has a black silt loam surface layer about 8 inches thick. The subsurface layer is very dark gray, mottled loam about 10 inches thick. The subsoil is mottled clay loam about 14 inches thick. It is dark olive gray in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled clay loam. In the deeper parts of some depressions, the soil is very poorly drained. In places it does not have a subsurface layer.

Included with these soils in mapping are small areas of Barnes and Cresbard soils and small areas of the moderately saline and nonsaline Vallers soils. These included soils make up 1 to 20 percent of the unit. The well drained Barnes soils are on convex side slopes and the crest of the wider knolls. The moderately well drained, alkali Cresbard soils are on the higher lying side slopes. The poorly drained Vallers soils are on flats.

The Hamerly soil is moderately slowly permeable and Tonka soil slowly permeable. Available water capacity is high in both soils. Runoff is slow on the Hamerly soil and is ponded on the Tonka soil. The shrink-swell potential is moderate in the Hamerly soil and high in the Tonka soil. A seasonal high water table is at a depth of 1.5 to 3 feet in the Hamerly soil and is above or near the surface of the Tonka soil.

Most areas are used for cultivated crops or for pasture. These soils are suited to small grain and sunflowers. The ponding is the main limitation. Also, soil blowing is a hazard. Surface drains improve the likelihood of timely tillage and seeding. Suitable outlets for these drains, however, generally are not available. Soil blowing can be controlled by field windbreaks, stripcropping, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition. Wetness hinders haying in some years.

The Hamerly soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. The Tonka soil is suited only if it is drained. Measures that control soil blowing help to protect seedlings from abrasion.

The Hamerly soil is poorly suited and the Tonka soil generally unsuited to septic tank absorption fields and building site development. The ponding on the Tonka soil and the wetness of the Hamerly soil are the main limitations. Also, the slow or moderately slow permeability is a limitation in septic tank absorption fields and the shrink-swell potential a limitation on most building sites. Soils that are better suited to these uses generally are nearby.

The capability subclass is IVw.

72—Gardena silt loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on glacial lake plains. Individual areas range from 15 to about 300 acres.

Typically, the surface soil is black silt loam about 14 inches thick. The subsoil is silt loam about 12 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of 60 inches is, in sequence downward, calcareous, pale brown silt loam; brown silt loam; yellowish brown, mottled silt loam; and yellowish brown, mottled very fine sandy loam. In some areas the surface soil is loam. In some swales the soil is somewhat poorly drained and has a calcareous layer within a depth of 16 inches. On some convex slopes the thickness of the surface soil combined with that of the subsoil is less than 16 inches. In places the soil contains more clay. In some areas that adjoin drainageways or beaches, it is gently sloping.

Included with this soil in mapping are small areas of Borup and Zell soils, which make up 1 to 10 percent of the unit. The poorly drained Borup soils are in swales and seepy areas. They have a calcareous layer within a depth of 16 inches. The well drained Zell soils are on the crest and shoulders of the higher lying ridges and on breaks to drainageways. They do not have a subsoil.

The Gardena soil is moderately permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture

rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. The seasonal wetness is a limitation in septic tank absorption fields and on sites for dwellings with basements. It can be reduced by surface drains. Subsurface drains help to prevent seepage into basements.

The capability subclass is IIe.

73—Glyndon silt loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained soil is on broad flats and in swales on glacial lake plains. Individual areas range from 10 to about 600 acres.

Typically, the surface layer is black silt loam about 10 inches thick. The upper part of the substratum is calcareous, dark grayish brown, mottled silt loam. The next part is calcareous, dark brown, mottled very fine sandy loam. The lower part to a depth of about 60 inches is multicolored very fine sandy loam. In places the surface soil is loam. On some of the higher lying swells, the soil is moderately well drained, has a subsoil, and does not have a calcareous layer within a depth of 16 inches. In some areas the substratum is fine sandy loam.

Included with this soil in mapping are small areas of the poorly drained Borup and Tiffany soils. These soils make up 5 to 10 percent of the unit. They are in the lower lying depressions, swales, and seepy areas. The Tiffany soils do not have a calcareous layer within a depth of 16 inches.

The Glyndon soil is moderately permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 2.5 to 6 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. The wetness caused by the seasonal high water table delays spring seeding in some years.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. The wetness is a limitation in septic tank absorption fields and on sites for dwellings with basements. Installing a drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements, but the seasonal high water table is a continuing limitation. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIe.

76—Borup silt loam. This deep, level, poorly drained soil is on broad flats and in swales on glacial lake plains and in seepy areas adjacent to beaches. The natural drainage pattern is poorly defined. Excess surface water ponds in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from 5 to about 100 acres.

Typically, the surface soil is black silt loam about 12 inches thick. The upper part of the substratum is calcareous, gray and dark gray silt loam. The lower part to a depth of about 60 inches is grayish brown, mottled very fine sandy loam. On some swells the soil is somewhat poorly drained. In places it does not have a calcareous layer within a depth of 16 inches. In some areas it contains more clay. In other areas it has a higher content of coarse sand.

Included with this soil in mapping are small areas of moderately saline soils. These soils make up as much as 5 percent of the unit.

The Borup soil is moderately rapidly permeable in the upper part and rapidly permeable in the lower part. Available water capacity is high. Runoff is very slow. A seasonal high water table is at a depth of 1 to 2.5 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes if excess water is removed. It is suitable for late seeded crops in most years. The wetness and a susceptibility to soil blowing are the main concerns of management. Excess surface water is removed from most areas by natural runoff, deep seepage, or constructed drains. Field windbreaks, crop residue management, stripcropping, and buffer strips help to control soil blowing.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development because of the wetness. A drainage system removes excess surface water, but the seasonal high water table is a continuing limitation. Soils that are better suited to these uses generally are nearby.

The capability subclass is IIw.

78B—Zell-Gardena silt loams, 1 to 6 percent slopes. These deep soils are on knolls, on ridges, and

on breaks along drainageways on glacial lake plains and in areas between old glacial beaches. The gently sloping, well drained Zell soil is on the crest and shoulders of slopes, and the nearly level, moderately well drained Gardena soil is on plane and slightly concave side slopes. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. Individual areas range from 5 to about 100 acres. They are about 50 percent Zell soil and 40 percent Gardena soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zell soil is black silt loam about 9 inches thick. The substratum to a depth of about 60 inches is very fine sandy loam. The upper part is calcareous and dark grayish brown, the next part is dark grayish brown, and the lower part is olive brown and mottled. In places the surface layer is very fine sandy loam. In some areas the substratum contains more clay.

Typically, the surface soil of the Gardena soil is black silt loam about 17 inches thick. The subsoil is very dark grayish brown silt loam about 26 inches thick. It is mottled in the lower part. The upper part of the substratum is calcareous, brown, mottled silt loam. The lower part to a depth of about 60 inches is yellowish brown, mottled very fine sandy loam. In places the soil has a calcareous layer within a depth of 16 inches. In some areas the surface soil is less than 17 inches thick. In some areas the soil contains more clay.

Included with these soils in mapping are small areas of the poorly drained Lamoure and Tiffany soils, which make up 1 to 10 percent of the unit. Lamoure soils contain more clay than the Zell and Gardena soils. They are on flood plains. Tiffany soils contain more sand than the Zell and Gardena soils. They are on the lower lying flats and in swales.

The Zell and Gardena soils are moderately permeable. Available water capacity is high. Runoff is medium on the Zell soil and slow on the Gardena soil. A seasonal high water table is at a depth of 4 to 6 feet in the Gardena soil.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing and water erosion are the main hazards. Field windbreaks, stripcropping, cover crops, and buffer strips help to control both soil blowing and water erosion. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. Grassed waterways help to control water erosion. Returning crop residue to the soil increases the infiltration rate and reduces the runoff rate.

A cover of pasture plants or hay is effective in controlling soil blowing and water erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to most of the trees and shrubs commonly grown as windbreaks and environmental plantings. Optimum survival, growth, and vigor are not likely, however, on the Zell soil. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. The wetness of the Gardena soil is a limitation in septic tank absorption fields and on sites for dwellings with basements. It can be reduced by installing a drainage system. Subsurface drains help to prevent seepage into basements. The moderate permeability of the Zell soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The capability subclass is IIIe.

78C—Zell-Gardena silt loams, 1 to 9 percent slopes. These deep soils are on knolls, on ridges, and on breaks along drainageways on glacial lake plains and in areas between old glacial beaches. The moderately sloping, well drained Zell soil is on the crest and shoulders of slopes, and the nearly level and gently sloping, moderately well drained Gardena soil is on plane and slightly concave side slopes. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. Individual areas range from 5 to about 100 acres. They are about 55 percent Zell soil and 40 percent Gardena soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zell soil is black silt loam about 9 inches thick. The substratum to a depth of about 60 inches is very fine sandy loam. The upper part is calcareous and dark grayish brown, the next part is dark grayish brown, and the lower part is olive brown and mottled. In places the surface layer is very fine sandy loam. In some areas the substratum contains more clay.

Typically, the surface soil of the Gardena soil is black silt loam about 14 inches thick. The subsoil is silt loam about 12 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is, in sequence downward, calcareous, pale brown silt loam; brown silt loam; yellowish brown, mottled silt loam; and yellowish brown, mottled very fine sandy loam. In places the soil has a calcareous layer within a depth of 16 inches. In some areas the surface soil is less than 14 inches thick. In other areas the soil contains more clay.

Included with these soils in mapping are small areas of the poorly drained Lamoure and Tiffany soils, which make up 1 to 5 percent of the unit. Lamoure soils contain more clay than the Zell and Gardena soils. They are on flood plains. Tiffany soils contain more sand than the Zell and Gardena soils. They are on the lower lying flats and in swales.

The Zell and Gardena soils are moderately permeable. Available water capacity is high. Runoff is rapid on the Zell soil and slow on the Gardena soil. A seasonal high water table is at a depth of 4 to 6 feet in the Gardena soil.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing and water erosion are the main hazards. Field windbreaks, stripcropping, cover crops, and buffer strips help to control both soil blowing and water erosion. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. Grassed waterways help to control water erosion. Returning crop residue to the soil increases the infiltration rate and reduces the runoff rate.

A cover of pasture plants or hay is effective in controlling soil blowing and water erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to most of the trees and shrubs commonly grown as windbreaks and environmental plantings. Optimum survival, growth, and vigor are not likely, however, on the Zell soil. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. The wetness of the Gardena soil is a limitation in septic tank absorption fields and on sites for dwellings with basements. It can be reduced by installing a drainage system. Subsurface drains help to prevent seepage into basements. The moderate permeability of the Zell soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The capability subclass is IVe.

79B—Zell-LaDelle silt loams, 1 to 6 percent slopes. These deep soils are along drainageways on glacial lake plains. The gently sloping, well drained Zell soil is on the crest and shoulders of slopes, and the nearly level, moderately well drained LaDelle soil is on stream terraces. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. Individual areas range from 5 to about 100 acres. They are about 50 percent Zell soil and 45 percent LaDelle soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zell soil is black silt loam about 10 inches thick. The substratum to a depth of about 60 inches is multicolored silt loam. In places the surface layer is silty clay loam. In some areas the substratum is very fine sandy loam or silty clay loam.

Typically, the surface soil of the LaDelle soil is black silt loam about 34 inches thick. The substratum to a depth of about 60 inches is dark grayish brown silty clay loam. It is mottled in the lower part. In some areas the surface soil is loam or silty clay loam. On some side slopes it is less than 18 inches thick. In some of the lower lying areas on flood plains, the soil is occasionally flooded during periods of spring runoff and heavy rainfall. In places the substratum contains less clay.

Included with these soils in mapping are small areas of Bearden, Lamoure, Ojata, and Rauville soils, which make up 1 to 10 percent of the unit. The somewhat poorly drained Bearden soils are on the lower lying slopes. The poorly drained Lamoure and very poorly drained Rauville soils are on flood plains and bottom land. The poorly drained Ojata soils are on the lower lying flats. They are very strongly saline.

The Zell and LaDelle soils are moderately permeable. Available water capacity is high. Runoff is medium on the Zell soil and slow on the LaDelle soil. The LaDelle soil has a seasonal high water table at a depth of 4 to 6 feet. It has a moderate shrink-swell potential.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing and water erosion are the main hazards. They can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. In areas where the Zell soil is fall tilled, soil blowing can be controlled by leaving crop residue on the surface throughout the winter. Returning crop residue to the soil increases the infiltration rate and reduces the runoff rate. The wetness resulting from spring runoff and heavy rainfall interferes with fieldwork on the LaDelle soil in some years.

A cover of pasture plants or hay is effective in controlling soil blowing and water erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to most of the commonly grown trees and shrubs. Optimum survival, growth, and vigor are not likely, however, on the Zell soil. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. The wetness of the LaDelle soil is a limitation in septic tank absorption fields and on sites for dwellings with basements. Surface drains and channels help to remove excess water. Subsurface drains help to prevent seepage into basements. The shrink-swell potential of the LaDelle soil is a limitation on building sites, but it can be overcome by installing surface and foundation drains and by reinforcing basement and foundation walls. The moderate permeability in both soils is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The capability subclass is IIIe.

79C—Zell-LaDelle silt loams, 1 to 9 percent slopes. These deep soils are along drainageways on glacial lake plains. The moderately sloping, well drained Zell soil is on the crest and shoulders of slopes, and the nearly level and gently sloping, moderately well drained LaDelle soil is on stream terraces. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. Individual areas range from 5 to about 100 acres. They are about 50 percent Zell soil and 40 percent LaDelle soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zell soil is very dark gray silt loam about 8 inches thick. The substratum to a depth of about 60 inches is mottled silty clay loam. It is dark grayish brown in the upper part and dark gray in the lower part. In places the surface layer is silty clay loam. In some areas the substratum is very fine sandy loam or silt loam.

Typically, the surface soil of the LaDelle soil is black silt loam about 34 inches thick. The substratum to a depth of about 60 inches is mottled silty clay loam. It is very dark gray in the upper part and very dark grayish brown in the lower part. In places the surface soil is loam or silty clay loam. On some side slopes it is less than 18 inches thick. In some of the lower lying areas along drainageways, the soil is occasionally flooded. In some areas the substratum contains less clay.

Included with these soils in mapping are small areas of Bearden, Lamoure, Ojata, and Rauville soils, which make up 1 to 15 percent of the unit. The somewhat poorly drained Bearden soils are on the lower lying slopes. The poorly drained Lamoure and very poorly drained Rauville soils are on flood plains and bottom land. The poorly drained Ojata soils are on the lower lying flats. They are very strongly saline.

The Zell and LaDelle soils are moderately permeable. Available water capacity is high. Runoff is rapid on the Zell soil and slow on the LaDelle soil. The LaDelle soil has a seasonal high water table at a depth of 4 to 6 feet. It has a moderate shrink-swell potential.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing and water erosion are the main hazards. They can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. In areas where the Zell soil is fall tilled, soil blowing can be controlled by leaving crop residue on the surface throughout the winter. Returning crop residue to the soil increases the infiltration rate and reduces the runoff rate. The wetness resulting from spring runoff and heavy rainfall interferes with fieldwork on the LaDelle soil in some years.

A cover of pasture plants or hay is effective in controlling soil blowing and water erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to most of the commonly grown trees and shrubs. Optimum survival, growth, and vigor are not likely, however, on the Zell soil. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. The wetness of the LaDelle soil is a limitation in septic tank absorption fields and on sites for dwellings with basements. Surface drains and channels help to remove excess water. Subsurface drains help to prevent seepage into basements. The shrink-swell potential of the LaDelle soil is a limitation on building sites, but it can be overcome by installing surface and foundation drains and by reinforcing basement and foundation walls. The moderate permeability in both soils is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The capability subclass is IVe.

79D—Zell-LaDelle silt loams, 1 to 15 percent slopes. These deep soils are along drainageways on glacial lake plains. The moderately sloping and strongly sloping, well drained Zell soil is on the crest and shoulders of slopes, and the nearly level and gently sloping, moderately well drained LaDelle soil is on stream terraces. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. Individual areas range from 5 to about 100 acres. They are about 55 percent Zell soil and 35 percent LaDelle soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zell soil is very dark gray silt loam about 8 inches thick. The upper part of the substratum is dark grayish brown and grayish brown silt loam. The lower part to a depth of about 60 inches is very dark gray silty clay loam. In places the surface layer is silty clay loam. In some areas the substratum is very fine sandy loam.

Typically, the surface soil of the LaDelle soil is black silt loam about 34 inches thick. The substratum to a depth of about 60 inches is silty clay loam. It is dark grayish brown and dark gray and mottled in the upper part and is black in the lower part. In places the surface soil is loam or silty clay loam. On some side slopes it is less than 18 inches thick. In some of the lower lying areas along drainageways, the soil is occasionally flooded. In some areas the substratum contains less clay.

Included with these soils in mapping are small areas of Bearden, Lamoure, Ojata, and Rauville soils, which make up 1 to 15 percent of the unit. The somewhat poorly drained Bearden soils are on the lower lying slopes. The poorly drained Lamoure and very poorly drained Rauville soils are on flood plains and bottom land. The poorly drained Ojata soils are on the lower lying flats. They are very strongly saline.

The Zell and LaDelle soils are moderately permeable. Available water capacity is high. Runoff is rapid on the Zell soil and slow on the LaDelle soil. The LaDelle soil has a seasonal high water table at a depth of 4 to 6 feet. It has a moderate shrink-swell potential.

Most areas are idle. These soils are unsuited to most cultivated crops and to hay because of a high susceptibility to soil blowing and water erosion and the slope. They are best suited to pasture. A permanent cover of pasture plants is effective in controlling soil blowing and water erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing are needed.

The Zell soil generally is unsuited to trees and shrubs. Scalp-planted trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are not likely. No critical limitations affect trees and shrubs on the LaDelle soil. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for buildings. The slope of the Zell soil and the shrink-swell potential of the LaDelle soil are the main limitations. Also, the wetness of the LaDelle soil is a limitation on sites for dwellings with basements. Buildings should be constructed in the less sloping areas. If constructed on the Zell soil, they should be designed to conform to the natural slope of the land. Land shaping is needed in some areas. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the damage caused by the shrinking and swelling of the LaDelle soil. Surface drains and channels help to remove excess water. Subsurface drains help to prevent seepage into basements.

These soils are suitable as septic tank absorption fields. The moderate permeability of both soils, the wetness of the LaDelle soil, and the slope of the Zell soil are limitations. The slow absorption of liquid waste can be overcome by enlarging the absorption field. The wetness can be reduced by installing a drainage system. The slope can be overcome by land shaping and by installing the distribution lines across the slope.

The capability subclass is VIe.

84—Wyndmere-Embden sandy loams. These deep, level soils are on delta plains and beaches. The somewhat poorly drained Wyndmere soil is on the lower lying flats and in swales. The moderately well drained Embden soil is on the higher lying swells. Individual areas range from 10 to about 100 acres. They are about 50 percent Wyndmere soil and 45 percent Embden soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Wyndmere soil has a black sandy loam surface layer about 10 inches thick. The upper part of the substratum is calcareous, gray and grayish brown sandy loam. The next part is brown loamy fine sand. The lower part to a depth of about 60 inches is pale brown, mottled fine sand. In some of the deeper swales and depressions, the calcareous layer is below a depth of 16 inches.

Typically, the Embden soil has a black sandy loam surface layer about 10 inches thick. The subsoil is black sandy loam about 13 inches thick. The upper part of the substratum is brown sandy loam. The lower part to a depth of about 60 inches is brown, stratified fine sand and loamy fine sand. In places the lower part of the substratum is sand and gravel. In some areas the sand fraction is dominantly shale fragments.

Included with these soils in mapping are small areas of the poorly drained Arveson and Hamar soils, which make up 1 to 10 percent of the unit. These included soils are in the deeper swales and in seepy areas. The Hamar soils contain more sand and less clay than the Wyndmere and Embden soils.

The Wyndmere and Embden soils are moderately rapidly permeable. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 2 to 5 feet in the Wyndmere soil and 3.5 to 6 feet in the Embden soil.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Wetness delays spring seeding on the Wyndmere soil in some years.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

The Embden soil is suitable as a site for septic tank absorption fields and buildings, but the Wyndmere soil is poorly suited. The wetness is the main limitation. Installing a drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

86—Divide loam, 1 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is in shallow swales, on flats, and in seepy areas on delta plains and beaches. It is moderately deep over sand and gravel. Individual areas range from about 5 to 150 acres.

Typically, the surface layer is black loam about 10 inches thick. The substratum to a depth of 60 inches is, in sequence downward, calcareous, grayish brown loam; calcareous, light brownish gray gravelly clay loam; light olive brown gravelly sand; brown, mottled sand; and light olive brown, mottled fine sand. In places the surface layer is silt loam or clay loam. In some areas the soil is poorly drained. In other areas it contains less clay in the upper part.

Included with this soil in mapping are small areas of Arvilla and Renshaw soils, which make up 1 to 10 percent of the unit. These somewhat excessively drained soils are on the higher lying knolls and ridges.

The Divide soil is moderately permeable in the upper part and very rapidly permeable in the lower part. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 2.5 to 5 feet.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Droughtiness, a result of the moderate depth over sand and gravel, is the

main concern of management. Also, soil blowing is a hazard. Crop residue management and green manure crops conserve soil moisture. Field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. Wetness delays fieldwork in the spring of some years.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings, but only the drought tolerant species can obtain maximum growth and vigor. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for buildings. The wetness is a limitation on sites for dwellings with basements. Subsurface drains help to prevent seepage into basements. The sides of shallow excavations tend to cave in unless they are shored.

This soil is poorly suited to septic tank absorption fields because of the wetness and the very rapid permeability. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water. A drainage system reduces the wetness, but the seasonal high water table is a continuing limitation.

The capability subclass is IIIs.

87—Marysland loam. This deep, level, poorly drained soil is in swales, on broad flats, and in seepy areas on delta plains and beaches. It is moderately deep over sand and gravel. The natural drainage pattern is poorly defined. In some years excess surface water ponds in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from 5 to about 600 acres.

Typically, the surface layer is black loam about 6 inches thick. The next 10 inches is calcareous, black, mottled loam. The upper part of the substratum is calcareous, dark grayish brown, mottled sandy clay loam. The next part is olive brown gravelly coarse sand. The lower part to a depth of about 60 inches is dark yellowish brown, mottled very gravelly coarse sand. In some places the surface layer is clay loam. In other places the soil is somewhat poorly drained. In some areas it contains less clay in the upper part. In other areas it has a mottled subsoil.

Included with this soil in mapping are small areas of Rauville and Renshaw soils, which make up 1 to 10 percent of the unit. The very poorly drained Rauville soils are in seepy areas and on bottom land. They contain less sand than the Marysland soil. The somewhat excessively drained Renshaw soils are in the higher lying convex areas. They do not have a calcareous layer within a depth of 16 inches.

The Marysland soil is moderately permeable in the upper part and rapidly permeable in the lower part. Available water capacity is moderate. Runoff is ponded. A seasonal high water table is above the surface or within a depth of 2.5 feet.

Most areas are used for cultivated crops or for pasture or hay. A few areas are idle. This soil is suited to small grain and sunflowers if excess water is removed. It is suitable for late seeded crops in most years, but the seasonal ponding is a problem. Soil blowing is a hazard if cultivated crops are grown. Excess water is removed from most areas by natural runoff, deep seepage, or constructed drains. Field windbreaks, stripcropping, crop residue management, and buffer strips help to control soil blowing.

A cover of pasture plants or hay is effective in controlling soil blowing. Ponding interferes with haying in some years. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If drained, this soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and building site development because of the ponding. Surface drains help to control the ponding, but the seasonal high water table is a continuing limitation. Soils that are better suited to these uses generally are nearby.

The capability subclass is IIw.

89—Renshaw loam, 1 to 3 percent slopes. This deep, nearly level, somewhat excessively drained soil is on delta plains, beaches, and stream terraces. It is shallow over sand and gravel. Individual areas range from 5 to about 100 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is very dark gray sandy clay loam about 7 inches thick. The upper part of the substratum is calcareous, brown gravelly loamy sand. The next part is dark grayish brown and brown very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown coarse sand. In some areas the substratum contains more shale. On some of the concave side slopes, the surface layer and subsoil are thicker and the soil is moderately deep over sand and gravel. In places the surface layer is sandy loam.

Included with this soil in mapping are small areas of Divide and Sioux soils, which make up 1 to 15 percent of the unit. These soils do not have a subsoil. The somewhat poorly drained Divide soils are in seepy areas and swales. The excessively drained Sioux soils are on the crest and shoulders of knolls and ridges.

The Renshaw soil is moderately rapidly permeable in the upper part and very rapidly permeable in the lower part. Available water capacity is low. Runoff is slow.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Droughtiness, a

result of the low available water capacity, is the main concern of management. Also, soil blowing is a hazard. Crop residue management and green manure crops conserve soil moisture. Field windbreaks, stripcropping, crop residue management, cover crops, and buffer strips help to control soil blowing.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to the drought resistant trees and shrubs grown as windbreaks and environmental plantings. Optimum survival, growth, and vigor, however, are not likely.

This soil is suitable as a site for septic tank absorption fields and buildings. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIs.

89B—Renshaw loam, 3 to 6 percent slopes. This deep, gently sloping, somewhat excessively drained soil is on delta plains, beaches, and stream terraces. It is shallow over sand and gravel. Individual areas range from 5 to about 100 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is very dark gray sandy clay loam about 7 inches thick. The upper part of the substratum is calcareous, brown gravelly loamy sand. The next part is dark grayish brown and brown very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown coarse sand. In some areas the substratum contains more shale. On some of the concave side slopes, the surface layer and subsoil are thicker and the soil is moderately deep over sand and gravel. In places the surface layer is sandy loam.

Included with this soil in mapping are small areas of the excessively drained Sioux soils, which make up 1 to 10 percent of the unit. These soils are on the crest and shoulders of knolls and ridges. They do not have a subsoil.

The Renshaw soil is moderately rapidly permeable in the upper part and very rapidly permeable in the lower part. Available water capacity is low. Runoff is medium.

Most areas are used for cultivated crops or for pasture or hay. This soil is suited to small grain and sunflowers. Water erosion is the main hazard. Soil blowing also is a hazard. Droughtiness, a result of the low available water capacity, is a concern of management. Grassed waterways and diversions help to control water erosion. Crop residue management and green manure crops conserve soil moisture. Field windbreaks, stripcropping, crop residue management, cover crops, and buffer strips help to control soil blowing.

A cover of pasture plants or hay is effective in controlling water erosion and soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to the drought resistant trees and shrubs commonly grown as windbreaks and environmental plantings. Optimum survival, growth, and vigor, however, are not likely.

This soil is suitable as a site for septic tank absorption fields and buildings. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

90B—Arvilla sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, somewhat excessively drained soil is on delta plains and beaches. It is shallow or moderately deep over sand and gravel. Individual areas range from 5 to about 600 acres.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is very dark brown sandy loam about 11 inches thick. The upper part of the substratum is dark brown sand. The lower part to a depth of about 60 inches is brown gravelly coarse sand. In some concave areas, the surface layer and subsoil are thicker and the soil is deeper over sand and gravel. In some areas the substratum contains more shale. In places the soil is moderately sloping. In a few areas the surface layer is loam.

Included with this soil in mapping are small areas of Sioux and Wyndmere soils, which make up 1 to 15 percent of the unit. These soils do not have a subsoil. The excessively drained Sioux soils are on the crest and upper sides of knolls and ridges. The somewhat poorly drained Wyndmere soils are in seepy areas and swales.

The Arvilla soil is rapidly permeable. Available water capacity is low. Runoff is slow.

Most areas are used for cultivated crops or for pasture or hay. This soil is suited to small grain and sunflowers. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Droughtiness, a result of the low available water capacity, is a concern of management. Crop residue management and green manure crops conserve soil moisture.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to the drought resistant trees and shrubs. Optimum survival, growth, and vigor, however, are not likely. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. It readily absorbs but does not adequately filter the effluent in septic tank absorption

fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

93—Inkster sandy loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on delta plains and beaches. Individual areas range from 10 to about 3,000 acres.

Typically, the surface layer is black sandy loam about 6 inches thick. The subsoil is very dark gray sandy loam about 18 inches thick. It is mottled in the lower part. The upper part of the substratum is dark grayish brown, mottled sandy loam. The lower part to a depth of about 60 inches is dark olive gray, mottled loamy sand. In some areas the lower part of the substratum is sand and gravel. In other areas the soil contains more clay. In some swales it is somewhat poorly drained and has a calcareous layer within a depth of 16 inches. In places the sand fraction has a higher content of siliceous material and a lower content of weathered shale.

Included with this soil in mapping are small areas of Sioux and Tiffany soils, which make up 1 to 10 percent of the unit. The excessively drained Sioux soils are on the crest and shoulders of knolls and ridges. They are shallow or very shallow over sand and gravel.

The Inkster soil is moderately rapidly permeable in the upper part and rapidly permeable in the lower part. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 3.5 to 6 feet.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. Droughtiness, a result of the moderate available water capacity, is a limitation during extended dry periods. Crop residue management and green manure crops conserve soil moisture. Wetness delays spring seeding in some years.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. Wetness is a limitation in septic tank absorption fields and on sites for dwellings with basements. A drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements. The soil readily absorbs but does not adequately filter the effluent in the absorption fields. The poor filtering capacity may result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIe.

94—Pits, gravel. This map unit occurs as areas from which the soil material has been removed and the underlying sand and gravel mined. The areas generally support no vegetation. They range from 3 to about 100 acres.

The areas that are not mined are idle. This map unit generally is unsuited to farm uses unless the areas are leveled, topdressed with suitable topsoil, and otherwise reclaimed. On the bottom of unreclaimed pits, climatically suited trees and shrubs can be planted to enhance wildlife habitat or to increase the esthetic value. The suitability of species varies from pit to pit.

This map unit generally is unsuitable as a site for septic tank absorption fields and buildings unless it is leveled and reclaimed. Drainage outlets are needed in ponded areas and in areas where a seasonal high water table is evident. Onsite investigation is needed to determine the suitability for these uses.

No capability class or subclass is assigned.

95—Ojata silty clay loam. This deep, level, poorly drained, very strongly saline soil is on low lying flats and in sloughs and swales on glacial lake plains and in areas between old glacial beaches. The natural drainage pattern is poorly defined. Excess surface water is removed from most cultivated areas by constructed drains. Undrained areas typically support native grasses. Individual areas range from 10 to several thousand acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. It contains salt crystals. The upper part of the substratum is calcareous, gray, mottled silt loam. It contains salt crystals. The next part is dark grayish brown, mottled, very finely stratified silt loam. The lower part to a depth of about 60 inches is dark grayish brown and olive brown, mottled silt loam. In places the soil contains less clay throughout. In some of the areas between old glacial beaches, the substratum contains more sand. In some areas the soil is stony. In other areas it is moderately saline or strongly saline. It is very poorly drained in some sloughs and somewhat poorly drained on some of the higher lying swells.

Included with this soil in mapping are small areas of the nonsaline and slightly saline Bearden and Colvin soils and the moderately saline, ponded Lallie soils. These soils make up 1 to 15 percent of the unit. The somewhat poorly drained Bearden soils are on the higher lying convex slopes. The very poorly drained Lallie soils have a thin surface layer.

The Ojata soil is moderately slowly permeable. Available water capacity is moderate. Runoff is very slow. A seasonal high water table is at or near the surface.

Most areas are used for pasture or wildlife habitat. This soil is suited to native grass pasture and hay and to wetland wildlife habitat. It is unsuited to most cultivated

crops because of the salinity. Many of the waterfowl production and refuge areas in the county are areas of this soil. In the areas used for grazing, proper stocking rates, pasture rotation, and timely deferment of grazing are needed. Careful management is needed because the vegetation deteriorates very easily in overgrazed areas or in areas that are subject to heavy traffic.

This soil generally is unsuited to trees and shrubs because of the severe salinity. The seedling survival rate is very poor, and the surviving trees lack vigor, density, and mature height.

This soil is poorly suited to septic tank absorption fields and building site development. The wetness is the main limitation. A drainage system helps to remove excess surface water, but the seasonal high water table is a continuing limitation. The moderately slow permeability is a limitation in septic tank absorption fields. It can be overcome, however, by enlarging the field.

The capability subclass is VIs.

96D—Sioux-Barnes loams, 6 to 15 percent slopes. These deep soils are on knolls and ridges on till plains. The strongly sloping, excessively drained Sioux soil is on the crest and shoulders of the knolls and ridges. It is shallow or very shallow over sand and gravel. The moderately sloping and strongly sloping, well drained Barnes soil is on side slopes. Individual areas range from about 5 to 50 acres. They are about 50 percent Sioux soil and 35 percent Barnes soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is impractical.

Typically, the surface layer of the Sioux soil is black loam about 6 inches thick. The next 5 inches is very dark grayish brown gravelly sandy loam. The upper part of the substratum is dark grayish brown gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown coarse sand. In some places the substratum has more shale fragments. In other places the content of gravel in the substratum is less than 35 percent. In some areas the soil has a subsoil and has a surface layer that is more than 6 inches thick.

Typically, the surface soil of the Barnes soil is black loam about 11 inches thick. The subsoil is dark brown loam about 11 inches thick. The substratum to a depth of about 60 inches is loam. It is calcareous and grayish brown in the upper part and olive brown and mottled in the lower part. On some of the lower lying plane and concave slopes, the soil is moderately well drained and the surface soil is more than 11 inches thick.

Included with these soils in mapping are small areas of Buse, Cresbard, Hamerly, and Parnell soils, which make up 5 to 15 percent of the unit. The well drained Buse soils are on the crest and shoulders of slopes. They do not have a subsoil. The moderately well drained, alkali Cresbard soils are on plane side slopes. The somewhat poorly drained Hamerly soils are on the lower lying concave side slopes. They have a calcareous layer within a depth of 16 inches. The very poorly drained Parnell soils are in depressions.

Permeability is very rapid in the Sioux soil and moderately slow in the Barnes soil. Available water capacity is very low in the Sioux soil and high in the Barnes soil. Runoff is slow on the Sioux soil and rapid on the Barnes soil. The shrink-swell potential is moderate in the Barnes soil.

Most areas are used for pasture (fig. 7) or are idle. Some areas are used for cultivated crops. These soils are unsuited to most cultivated crops and to hay because the Sioux soil is droughty, because most areas are too steep, and because soil blowing and water erosion are hazards. A cover of native pasture grasses is effective in controlling erosion and soil blowing if the pasture is kept in good condition. Proper stocking rates, pasture rotation, and timely deferment of grazing are needed.

The Barnes soil is suited to nearly all of the trees and shrubs commonly grown as windbreaks and environmental plantings. The Sioux soil generally is unsuited, however, because it is droughty. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for buildings. The slope is the main limitation. Also, the shrink-swell potential of the Barnes soil is a limitation on sites for dwellings. The buildings should be designed to conform to the natural slope of the land. Land shaping is needed in some areas. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the damage caused by the shrinking and swelling of the Barnes soil. The sides of shallow excavations in the Sioux soil tend to cave in unless they are shored.

These soils are suitable as septic tank absorption fields. The Sioux soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water. The moderately slow permeability of the Barnes soil is a limitation, but it can be overcome by enlarging the absorption field.

The capability subclass is VIs.

97D—Sioux loam, 1 to 15 percent slopes. This deep, nearly level to strongly sloping, excessively drained soil is on the crest and shoulders of knolls, ridges, and breaks to valleys on till plains, delta plains, and beaches. It is shallow or very shallow over sand and gravel. Individual areas range from 5 to about 100 acres.

Typically, the surface layer is black loam about 7 inches thick. The next 3 inches is very dark grayish brown very gravelly sandy loam. The upper part of the substratum is dark grayish brown gravelly coarse sand and very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown coarse sand. In places the surface layer is gravelly loam, sandy loam, or

Figure 7.—A pastured area of Sioux-Barnes loams, 6 to 15 percent slopes.

gravelly sandy loam. In some areas the content of gravel is less than 35 percent. In other areas the substratum contains more shale fragments.

Included with this soil in mapping are small areas of Arvilla, Hecla, Renshaw, and Vang soils, which make up 1 to 15 percent of the unit. These soils are deeper over sand and gravel than the Sioux soil. They are on the lower lying side slopes. The Arvilla and Renshaw soils are somewhat excessively drained. The Hecla soils are moderately well drained. They have a lower content of coarse sand and gravel than the Sioux soil. The Vang soils are well drained.

The Sioux soil is very rapidly permeable. Available water capacity is very low. Runoff is slow.

Most areas are used for pasture or hay or are idle. This soil is unsuited to most cultivated crops and to hay because it is droughty and susceptible to soil blowing. A cover of native pasture grasses is effective in controlling soil blowing if the pasture is kept in good condition. Proper stocking rates, pasture rotation, and timely deferment of grazing are needed.

This soil is unsuited to most trees and shrubs. The droughtiness is a critical limitation affecting survival, growth, and vigor.

This soil is suitable as a site for septic tank absorption fields and buildings. The slope is a limitation on building sites. The buildings should be designed to conform to the natural slope of the land. Land shaping is needed in some areas. The sides of shallow excavations tend to cave in unless they are shored. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The capability subclass is VIIs.

98E—Edgeley-Kloten loams, 6 to 25 percent slopes. These well drained soils are in stream valleys on till plains. The moderately deep, moderately sloping and strongly sloping Edgeley soil is on plane and slightly concave side slopes, and the very shallow or shallow, strongly sloping and moderately steep Kloten soil is on convex shoulder slopes and the upper side slopes. Shale bedrock is exposed on some of the steeper cutbanks and in slump areas. Individual areas range from 50 to about 200 acres. They are about 55 percent Edgeley soil and 35 percent Kloten soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Edgeley soil has a black loam surface layer about 6 inches thick. The subsoil is about 30 inches thick. It is very dark grayish brown clay loam and shaly clay loam in the upper part and dark olive gray and

olive gray shaly clay loam in the lower part. The underlying material to a depth of about 60 inches is dark gray and gray weathered shale. In places the soil is deep over shale.

Typically, the Kloten soil has a very dark gray loam surface layer about 5 inches thick. The next 4 inches is very dark gray loam. Below this to a depth of about 60 inches is very dark gray and dark gray shale. In places the surface layer is shaly loam.

Included with these soils in mapping are small areas of Buse, Cresbard, Miranda Variant, Rauville, and Sioux soils, which make up 5 to 15 percent of the unit. The well drained Buse soils are on the crest and shoulders of slopes. They formed in till. The alkali Cresbard and Miranda Variant soils are on concave side slopes and toe slopes. The very poorly drained Rauville soils are on bottom land. Sioux soils are on the crest and shoulders of slopes. They are very shallow or shallow over sand and gravel.

The Edgeley and Kloten soils are moderately permeable. Available water capacity is moderate in the Edgeley soil and very low in the Kloten soil. Runoff is medium on the Edgeley soil and rapid on the Kloten soil. The underlying shale in both soils restricts the root zone. The shrink-swell potential is moderate in the Edgeley soil.

Most areas are used for pasture. Hay is harvested in some areas along drainageways and on the lower lying concave side slopes. These soils are unsuited to most cultivated crops and to hay because they are droughty, are susceptible to water erosion, and are moderately sloping to moderately steep. A cover of pasture plants is effective in controlling water erosion if the pasture is kept in good condition. Proper stocking rates, timely deferment of grazing, and pasture rotation are needed.

The Edgeley soil is suited to nearly all of the commonly grown trees and shrubs. The Kloten soil, however, generally is unsuited because it is droughty and has a severely restricted root zone.

The Edgeley soil is suitable as a site for septic tank absorption fields and buildings, but the Kloten soil is poorly suited. The restricted depth to bedrock and the slope are the main limitations. The less sloping areas where the soil is deeper should be selected as sites for these uses. The steeper areas generally are unstable and are subject to slumping. The buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping is needed in some areas. The shrink-swell potential of the Edgeley soil is a limitation on sites for dwellings. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is VIs.

99—Cavour-Miranda loams, 0 to 3 percent slopes. These deep, level and nearly level, alkali soils are on till plains. The moderately well drained Cavour soil is on the plane and slightly convex sides of low swells, and the somewhat poorly drained Miranda soil is in the lower lying swales and on flats. The soils are stony in some areas. Individual areas range from 5 to about 100 acres. They are about 50 percent Cavour soil and 40 percent Miranda soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Cavour soil has a black loam surface layer about 8 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is about 15 inches thick. It is black clay in the upper part and dark grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and grayish brown, mottled clay loam. In places the subsoil does not have columnar structure.

Typically, the Miranda soil has a very dark grayish brown loam surface layer about 3 inches thick. The subsoil is very dark grayish brown clay loam about 13 inches thick. It has salt crystals in the lower part. The substratum to a depth of about 60 inches is calcareous, brown loam and clay loam.

Included with these soils in mapping are small areas of Barnes, Hamerly, Parnell, and Svea soils, which make up 5 to 15 percent of the unit. These included soils do not have an alkali subsoil. Barnes soils are well drained and are on the higher lying convex side slopes. Hamerly soils are somewhat poorly drained and are on concave side slopes. They have a calcareous layer within a depth of 16 inches. Parnell soils are very poorly drained and are in depressions.

Permeability is slow in the Cavour soil and very slow in the Miranda soil. Available water capacity is moderate in both soils. Runoff is slow. The dense subsoil restricts the depth to which roots can penetrate. The shrink-swell potential is high in the Cavour soil and moderate in the Miranda soil.

Most areas are used for cultivated crops or for pasture. These soils are unsuited to most cultivated crops and to pasture and hay. Root penetration is restricted in the subsoil, and moisture stress restricts crop growth in most years. Planting green manure crops and returning crop residue to the soil increase the content of organic matter and thus improve tilth and soil structure. Including deep rooted legumes, such as alfalfa and sweetclover, in the cropping sequence helps to loosen the dense subsoil. Tilling when the soil is wet increases the extent of surface crusting and clodding, both of which result in a poor seedbed (fig. 8).

A cover of pasture plants or hay is effective in improving tilth. In the areas used for grazing, careful management that includes proper stocking rates, pasture rotation, and timely deferment of grazing is needed.

These soils generally are unsuited to trees and shrubs. The severe alkalinity and the restricted root zone are critical limitations affecting survival, growth, and vigor.

The Cavour soil is suitable as a site for septic tank absorption fields and buildings, but the Miranda soil is poorly suited. The slow permeability of the Cavour soil

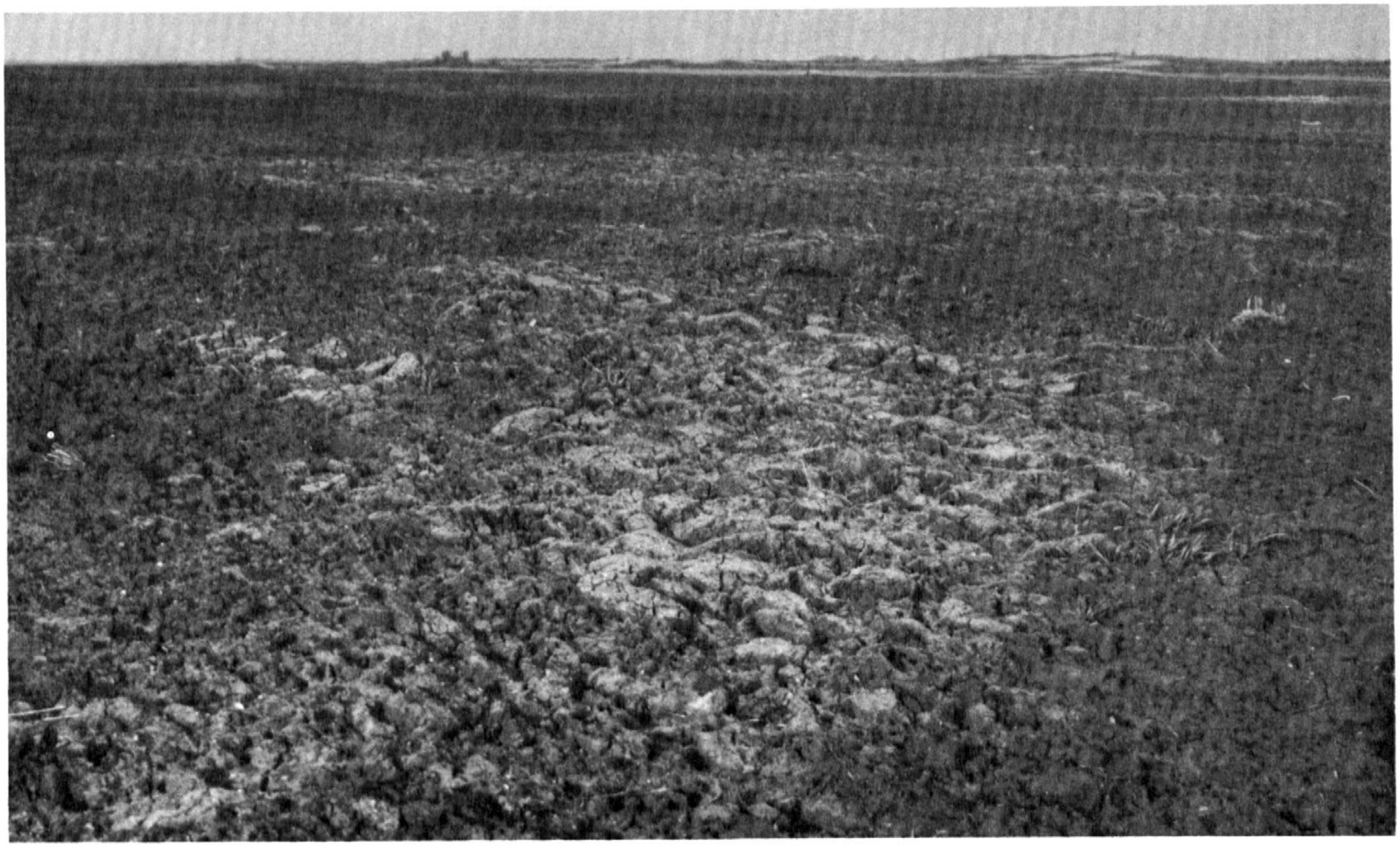

Figure 8.—Surface crusting and clodding on Cavour-Miranda loams, 0 to 3 percent slopes.

and the very slow permeability of the Miranda soil are limitations in septic tank absorption fields. The slow absorption of liquid waste in the Cavour soil can be overcome by enlarging the absorption field. Soils that are not so slowly permeable as the Miranda soil should be selected as sites for these absorption fields. The shrink-swell potential of both soils is a limitation on building sites. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IVs.

126—Bearden silty clay loam. This deep, level, somewhat poorly drained soil is on glacial lake plains. The natural drainage pattern is poorly defined, but excess surface water is removed from most areas by constructed drains. Undrained areas frequently are wet for short periods after spring runoff and heavy rainfall. Individual areas range from about 10 to several thousand acres.

Typically, the surface layer is black silty clay loam about 10 inches thick. The upper part of the substratum is calcareous, gray silty clay loam. The next part is light olive brown, mottled silt loam. The lower part to a depth of about 60 inches is grayish brown and light brownish gray, mottled silty clay loam. In some areas the soil is slightly saline. In other areas the surface layer is silt loam. In places the soil contains less clay. In some swales it is poorly drained, and in some it does not have a calcareous layer within a depth of 16 inches.

Included with this soil in mapping are small areas of the moderately saline Colvin and Bearden soils and the very strongly saline Ojata soils. These soils make up 1 to 15 percent of the unit. They generally occur as narrow areas along many of the road ditches and drainage ditches. Colvin and Ojata soils are poorly drained.

The Bearden soil is moderately slowly permeable. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 1.5 to 2.5 feet. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. Soil blowing is a hazard, however, if cultivated crops are grown. It can be controlled by field windbreaks, stripcropping, cover crops, and buffer strips. On fall tilled fields it can be controlled by leaving crop residue on the surface throughout the winter. The

wetness resulting from the seasonal high water table delays spring seeding in some years.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

This soil is suitable as a site for septic tank absorption fields and buildings. The wetness is the main limitation. Also, the moderately slow permeability is a limitation in septic tank absorption fields and the shrink-swell potential a limitation on sites for most buildings. A drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements, but the high water table is a continuing limitation. The slow absorption of liquid waste in the absorption fields can be overcome by enlarging the field. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIe.

130B—Svea-Buse loams, 1 to 6 percent slopes. These deep soils are on till plains. The nearly level, moderately well drained Svea soil is on the plane and concave lower side slopes, and the gently sloping, well drained Buse soil is on the crest and shoulders of knolls and ridges. Slopes are abruptly terminated by short, steep escarpments. Individual areas range from about 5 to 1,200 acres. They are about 60 percent Svea soil and 30 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Svea soil is black loam about 17 inches thick. The subsoil is very dark grayish brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is calcareous and grayish brown in the upper part and is olive brown in the lower part. On some of the convex side slopes, the soil is well drained and the surface soil is less than 17 inches thick. On some of the lower lying concave slopes, the soil is somewhat poorly drained, does not have a subsoil, and has a calcareous layer within a depth of 16 inches. In places it contains less clay throughout.

Typically, the surface layer of the Buse soil is very dark gray loam about 8 inches thick. The upper part of the substratum is calcareous, light brownish gray loam. The lower part to a depth of about 60 inches is grayish brown, mottled clay loam. In places the surface layer is less than 8 inches thick. In some areas the soil contains less clay throughout.

Included with these soils in mapping are small areas of Cresbard, Parnell, Sioux, and Tonka soils and the moderately saline and nonsaline Vallers soils. These included soils make up 1 to 15 percent of the unit. The moderately well drained, alkali Cresbard soils are on plane side slopes. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The excessively drained Sioux soils are on the crest and shoulders of knolls. They are shallow or very shallow over sand and gravel. The poorly drained Vallers soils are on low lying flats. They have a calcareous layer within a depth of 16 inches.

The Svea and Buse soils are moderately slowly permeable. Available water capacity is high. Runoff is slow on the Svea soil and medium on the Buse soil. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. The shrink-swell potential is moderate in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. Soil blowing and water erosion are hazards, however, if cultivated crops are grown. Field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. Grassed waterways and diversions help to control water erosion. Returning crop residue to the soil increases the infiltration rate and reduces the runoff rate.

A cover of pasture plants or hay is effective in controlling water erosion and soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to the commonly grown trees and shrubs. Optimum survival, growth, and vigor are not likely, however, on the Buse soil. No critical limitations affect trees and shrubs on the Svea soil. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on sites for buildings, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The wetness of the Svea soil is a limitation on sites for dwellings with basements. Subsurface drains help to prevent seepage into basements.

The capability subclass is IIIe.

130C—Buse-Svea loams, 1 to 9 percent slopes. These deep soils are in stream valleys on till plains. The moderately sloping, well drained Buse soil is on the crest and shoulders of knolls and ridges. The nearly level and gently sloping, moderately well drained Svea soil is on the plane and concave lower side slopes. In some areas adjacent to streams, slopes are abruptly terminated by short, steep escarpments. Individual areas range from about 10 to more than 100 acres. They are about 55

percent Buse soil and 40 percent Svea soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Buse soil is very dark gray loam about 8 inches thick. The upper part of the substratum is calcareous, light brownish gray loam. The lower part to a depth of about 60 inches is grayish brown, mottled clay loam. In places the surface layer is less than 8 inches thick. In some areas the soil contains less clay throughout.

Typically, the surface soil of the Svea soil is black loam about 17 inches thick. The subsoil is very dark grayish brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is calcareous and grayish brown in the upper part and is olive brown in the lower part. On some of the convex side slopes, the soil is well drained and the surface soil is less than 17 inches thick. On some of the lower lying concave slopes, it is somewhat poorly drained, does not have a subsoil, and has a calcareous layer within a depth of 16 inches. In places it contains less clay.

Included with these soils in mapping are small areas of Cresbard, Parnell, Sioux, and Tonka soils and the moderately saline and nonsaline Vallers soils. These included soils make up 1 to 10 percent of the unit. The moderately well drained, alkali Cresbard soils are on plane side slopes. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The excessively drained Sioux soils are on the crest and shoulders of knolls and ridges. They are shallow or very shallow over sand and gravel. The poorly drained Vallers soils are on low lying flats. They have a calcareous layer within a depth of 16 inches.

The Buse and Svea soils are moderately slowly permeable. Available water capacity is high. Runoff is rapid on the Buse soil and slow on the Svea soil. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. The shrink-swell potential is moderate in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. Soil blowing and water erosion are hazards, however, if cultivated crops are grown. Field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. Grassed waterways and diversions help to control water erosion. Returning crop residue to the soil increases the infiltration rate and reduces the runoff rate.

A cover of pasture plants or hay is effective in controlling water erosion and soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to the commonly grown trees and shrubs. Optimum survival, growth, and vigor are not likely, however, on the Buse soil. No critical limitations affect trees and shrubs on the Svea soil. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on sites for buildings, but installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The wetness of the Svea soil is a limitation on sites for dwellings with basements. Subsurface drains help to prevent seepage into basements.

The capability subclass is IVe.

148—Wyndmere-Tiffany fine sandy loams. These deep, level soils are on delta plains and in areas between old glacial beaches. The somewhat poorly drained Wyndmere soil is on plane and slightly convex slopes, and the poorly drained Tiffany soil is in depressions and swales. The natural drainage pattern is poorly defined. Excess surface water occasionally ponds in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from 15 to about 600 acres. They are about 55 percent Wyndmere soil and 35 percent Tiffany soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Wyndmere soil has a black fine sandy loam surface layer about 8 inches thick. The upper part of the substratum is calcareous, grayish brown and dark brown, mottled fine sandy loam. The next part is dark yellowish brown, mottled loamy fine sand. The lower part to a depth of about 60 inches is dark yellowish brown, mottled loamy very fine sand. In some places the substratum is sand or loamy sand throughout. In other places the surface layer is loam. In some areas the soil is moderately well drained and does not have a calcareous layer within a depth of 16 inches. In other areas it contains less sand.

Typically, the Tiffany soil has a black fine sandy loam surface layer about 10 inches thick. The next 13 inches is very dark gray and dark grayish brown, mottled fine sandy loam. The upper part of the substratum is olive brown, mottled fine sandy loam. The lower part to a depth of about 60 inches is light olive brown and light brownish gray, mottled, stratified fine sandy loam, loamy fine sand, and loamy very fine sand. In places the surface layer is loam. In some areas the upper part of the substratum is calcareous.

Included with these soils in mapping are small areas of the poorly drained Arveson and Hamar soils, which make up 1 to 10 percent of the unit. These included soils are in the deeper parts of swales and in seepy areas. The Hamar soils contain more sand than the Wyndmere and Tiffany soils.

Permeability is moderately rapid in the Wyndmere soil and moderate in the Tiffany soil. Available water capacity

is moderate in both soils. Runoff is slow on the Wyndmere soil and is ponded on the Tiffany soil. A seasonal high water table is at a depth of 2 to 5 feet in the Wyndmere soil and is above the surface or within 3 feet of the surface of the Tiffany soil.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, and potatoes if excess water is removed. They are suitable for late seeded crops in most years, but the seasonal ponding on the Tiffany soil is a problem. The ponding and a susceptibility to soil blowing are the main concerns of management. Excess surface water is removed from most areas by deep seepage, natural runoff, or constructed drains. Field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The Wyndmere soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings, but the Tiffany soil is suited only if it is drained. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields and building site development. The ponding is the main limitation. A drainage system helps to control the ponding on the Tiffany soil, but the seasonal high water table in both soils is a continuing limitation. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIIw.

171—Antler-Tonka silt loams. These deep, level soils are in areas between old glacial beaches. The somewhat poorly drained Antler soil is on broad flats, and the poorly drained Tonka soil is in depressions. The natural drainage pattern is poorly defined, but excess surface water is removed from most areas by constructed drains. Undrained depressions frequently are ponded for long periods during spring runoff and heavy rainfall. The soils are stony in most areas. Individual areas range from 10 to several thousand acres. They are about 55 percent Antler soil and 35 percent Tonka soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Antler soil is black silt loam about 9 inches thick. The upper part of the substratum is calcareous, gray silt loam. The next part is calcareous, light olive brown silty clay loam. The lower part to a depth of about 60 inches is light olive brown, mottled silt loam and clay loam. In some places the surface layer is loam, silty clay loam, or clay loam. In other places the substratum is silty clay loam. In some areas the soil is poorly drained. In other areas it is slightly saline.

Typically, the surface layer of the Tonka soil is black silt loam about 11 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 8 inches thick. The subsoil is very dark grayish brown and dark grayish brown, mottled silty clay loam about 15 inches thick. The substratum to a depth of about 60 inches is gray, mottled clay loam. In some depressions the surface layer is silty clay loam or silty clay. In some places the soil does not have a subsurface layer. In other places the subsurface layer is sandy loam.

Included with these soils in mapping are small areas of the moderately saline Antler soils and small areas of Parnell soils. These included soils make up 1 to 15 percent of the unit. The very poorly drained Parnell soils are in the deeper depressions.

Permeability is moderately slow in the Antler soil and slow in the Tonka soil. Available water capacity is high in both soils. Runoff is very slow on the Antler soil and is ponded on the Tonka soil. A seasonal high water table is at a depth of 1 to 4 feet in the Antler soil and is above or near the surface of the Tonka soil. The shrink-swell potential is high in the Tonka soil.

Most areas are used for cultivated crops. If adequately drained, these soils are suited to small grain and sunflowers. The ponding is the main limitation. Also, soil blowing is a hazard. Surface drains improve the likelihood of timely tillage and seeding. Field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. In most areas stones and boulders interfere with fieldwork.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The Antler soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings, but the Tonka soil is suited only if it is drained. Measures that control soil blowing help to protect seedlings from abrasion.

The Tonka soil generally is unsuitable as a site for septic tank absorption fields and buildings because it is subject to ponding. The Antler soil is poorly suited because of wetness. Also, its moderately slow permeability is a limitation in septic tank absorption fields. Installing a drainage system in the Antler soil reduces the wetness in the absorption fields and helps to prevent seepage into basements, but the seasonal high water table is a continuing limitation. The slow absorption of liquid waste can be overcome by enlarging the absorption field.

The capability subclass is IIw.

173—Glyndon-Tiffany silt loams. These deep, level soils are on glacial lake plains. The somewhat poorly drained Glyndon soil is on plane and slightly convex slopes, and the poorly drained Tiffany soil is in depressions and swales. The natural drainage pattern is poorly defined. Excess surface water occasionally ponds

in the lower lying areas for brief periods during spring runoff and heavy rainfall. Individual areas range from 30 to about 1,000 acres. They are about 60 percent Glyndon soil and 30 percent Tiffany soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Glyndon soil is black silt loam about 13 inches thick. The upper part of the substratum is calcareous, dark grayish brown and light olive brown, mottled silt loam. The next part is olive brown, mottled silt loam. The lower part to a depth of about 60 inches is olive brown, stratified very fine sandy loam. In some areas the soil is moderately well drained and has a subsoil. In other areas it is poorly drained. In places the substratum contains coarser sand.

Typically, the surface layer of the Tiffany soil is black silt loam about 8 inches thick. The next 11 inches is black silt loam. The subsoil is very dark gray, mottled silt loam about 12 inches thick. The upper part of the substratum is calcareous, light yellowish brown, mottled silt loam. The lower part to a depth of about 60 inches is olive brown and light olive brown, mottled very fine sandy loam. In some areas the soil contains more clay.

Included with these soils in mapping are small areas of Zell soils, which make up 1 to 10 percent of the unit. These well drained included soils are on the crest and shoulders of low knolls.

The Glyndon and Tiffany soils are moderately permeable. Available water capacity is high in the Glyndon soil and moderate in the Tiffany soil. Runoff is slow on the Glyndon soil and is ponded on the Tiffany soil. A seasonal high water table is at a depth of 2.5 to 6 feet in the Glyndon soil and is above the surface or within 3 feet of the surface of the Tiffany soil.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. The ponding on the Tiffany soil and the susceptibility of the Glyndon soil to soil blowing are the main concerns of management. Surface drains help to control the ponding and improve the likelihood of timely tillage and seeding. Field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The Glyndon soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings, but the Tiffany soil is suited only if it is drained. Measures that control soil blowing help to protect seedlings from abrasion.

The Glyndon soil is suitable as a site for septic tank absorption fields and buildings. The Tiffany soil is poorly suited, however, because it is subject to ponding. A drainage system helps to control the ponding, but the seasonal high water table is a continuing limitation. Installing a drainage system in the Glyndon soil reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements. The sides of shallow excavations tend to cave in unless they are shored.

The capability subclass is IIw.

199D—Miranda Variant loam, 1 to 15 percent slopes. This moderately deep, nearly level to strongly sloping, moderately well drained, alkali soil is on the sides of stream valleys on till plains. Shale bedrock is exposed on some of the steeper side slopes and in slump areas. Individual areas range from 50 to about 200 acres.

Typically, the surface soil is black loam about 4 inches thick. The subsoil is clay about 21 inches thick. The upper part is black. The lower part is dark olive gray and mottled. It has masses of gypsum crystals. The underlying material to a depth of about 60 inches is gray and dark gray shale. In places the soil has a surface layer that is more than 4 inches thick and does not have shale within a depth of 40 inches.

Included with this soil in mapping are small areas of Barnes, Edgeley, Kloten, and Svea soils, which make up 5 to 15 percent of the unit. These soils do not have an alkali subsoil. The well drained Barnes and moderately well drained Svea soils are on side slopes. They formed in till. The well drained Kloten soils are on convex shoulder slopes and the upper side slopes. They are very shallow or shallow over shale.

The Miranda Variant soil is very slowly permeable. Available water capacity is low. Runoff is medium. The shrink-swell potential is high. The dense subsoil and underlying shale restrict the depth to which roots can penetrate.

Most areas are used for pasture or are idle. Hay is harvested in a few areas. This soil is unsuited to most cultivated crops and to pasture and hay. The restricted root zone is the main limitation. Also, moisture stress severely restricts crop growth in most years. Forage production generally is poor, and pastures deteriorate easily if overgrazed. If pastures are overgrazed or grazed when the soil is wet, surface compaction is a problem, tilth deteriorates, and the runoff rate increases.

This soil generally is unsuited to trees and shrubs. The severe alkalinity and the restricted root zone are critical limitations affecting survival, growth, and vigor.

This soil generally is unsuitable as a site for septic tank absorption fields and buildings. The very slow permeability and the depth to bedrock are limitations in septic tank absorption fields. Soils that are better suited to this use generally are nearby. The shrink-swell potential is the main limitation on building sites. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is VIIs.

226—Bearden-Perella silty clay loams. These deep, level soils are on swells and in swales and shallow

depressions on glacial lake plains. The somewhat poorly drained Bearden soil is on plane and slightly convex slopes, and the poorly drained Perella soil is in depressions. The natural drainage pattern is poorly defined, but excess surface water is removed from most areas by constructed drains. Undrained depressions frequently are ponded for brief periods. Individual areas range from 5 to about 800 acres. They are about 65 percent Bearden soil and 30 percent Perella soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Bearden soil is black silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is, in sequence downward, calcareous, gray silt loam; calcareous, dark grayish brown silty clay loam; light olive brown silt loam; and olive brown, mottled silt loam. In some places the surface layer is silt loam. In other places the soil is slightly saline. In some areas it contains more sand throughout. In other areas it contains less clay throughout. In some swales it is poorly drained.

Typically, the surface soil of the Perella soil is black silty clay loam about 11 inches thick. The subsoil is black and very dark grayish brown, mottled silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is grayish brown and olive brown, mottled silty clay loam. In some areas the surface layer is silt loam. In other areas the subsoil contains more clay. In places the soil contains more sand.

Included with these soils in mapping are small areas of the moderately saline Bearden soils and small areas of Overly and Zell soils. These included soils make up 1 to 10 percent of the unit. The Bearden soils generally occur as narrow areas along many of the road ditches and drainage ditches. The moderately well drained Overly soils are in the slightly higher areas. The well drained Zell soils are on the crest of the higher lying knolls and along breaks to drainageways.

The Bearden and Perella soils are moderately slowly permeable. Available water capacity is high. Runoff is slow on the Bearden soil and is ponded on the Perella soil. A seasonal high water table is at a depth of 1.5 to 2.5 feet in the Bearden soil and is above or near the surface of the Perella soil. The shrink-swell potential is moderate in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. The ponding on the Perella soil (fig. 9) and the susceptibility of the Bearden soil to soil blowing are the main concerns of management. Surface drains help to control the ponding and increase the likelihood of timely tillage and seeding. Field windbreaks, stripcropping, and buffer strips help to control soil blowing.

A cover of hay or pasture plants is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The Bearden soil is suited to all of the trees and shrubs commonly grown as windbreaks and environmental plantings, but the Perella soil is suited only if it is drained. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields and building site development. The ponding is the

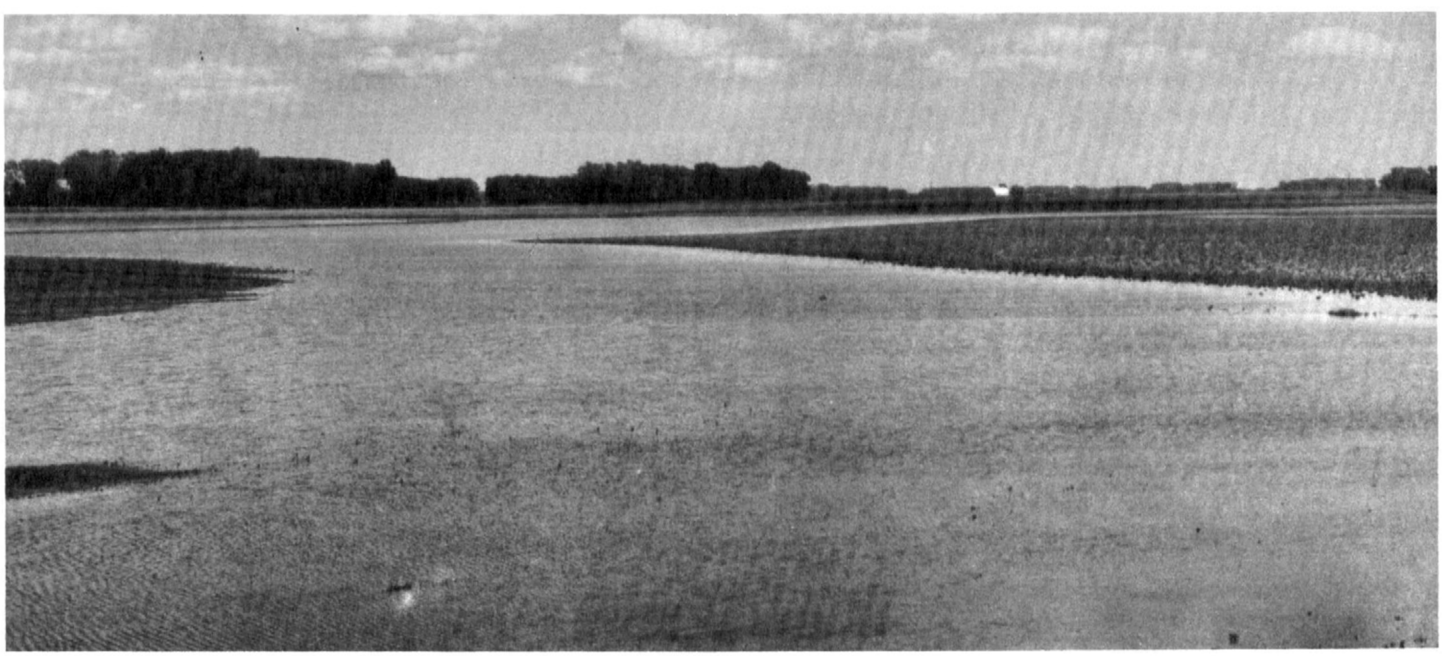

Figure 9.—Ponding on the Perella soil in an area of Bearden-Perella silty clay loams.

main limitation. Also, the moderately slow permeability is a limitation in septic tank absorption fields and the shrink-swell potential a limitation on sites for most buildings. A drainage system helps to control the ponding in septic tank absorption fields and helps to prevent seepage into basements, but the seasonal high water table is a continuing limitation. The slow absorption of liquid waste in the absorption fields can be overcome by enlarging the field. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIw.

270—Bearden silty clay loam, saline. This deep, level, somewhat poorly drained, moderately saline soil is on long, narrow swells and swales on glacial lake plains. It generally is more saline on the swells than in the swales. The natural drainage pattern is poorly defined, but excess surface water is removed from most areas by constructed drains. Undrained areas generally support native grasses. Individual areas range from 10 to several thousand acres.

Typically, the surface soil is black silty clay loam about 13 inches thick. It contains salt crystals (fig. 10). The upper part of the substratum is calcareous, very dark gray, mottled silt loam that contains salt crystals. The next part is olive brown, mottled silt loam. The lower part to a depth of about 60 inches is multicolored silt loam. In some areas the surface soil is silt loam or silty clay. In some places the soil is slightly saline or strongly saline. In other places it contains less clay throughout.

Included with this soil in mapping are small areas of the nonsaline Bearden, Colvin, and Perella soils and the very strongly saline Ojata soils. These soils make up 5 to 15 percent of the unit. Colvin, Ojata, and Perella soils are poorly drained and are in the lower lying areas.

The Bearden soil is moderately slowly permeable. Available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 1.5 to 2.5 feet. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, sugar beets, and potatoes. The salinity is the main limitation. Also, soil blowing is a hazard. Moderately salt tolerant crops, such as barley, rye, oats, and wheat, can be grown. Once established, sugar beets and alfalfa also are moderately salt tolerant, but the seedlings exhibit low tolerance. Stripcropping, buffer strips, and cover crops help to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields. The wetness resulting from the seasonal high water table delays seeding in some years.

A cover of pasture plants or hay is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

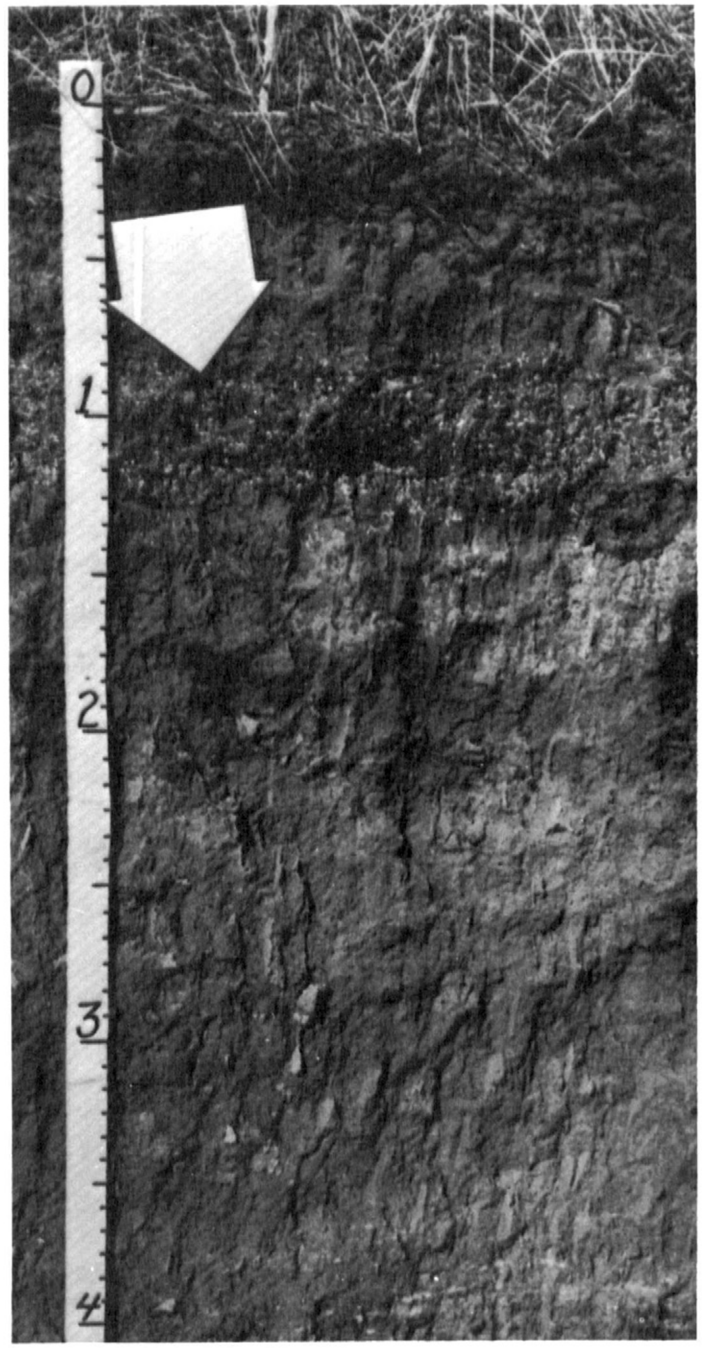

Figure 10.—Profile of Bearden silty clay loam, saline. Salt crystals are between depths of 10 and 14 inches. (Photo courtesy of F. M. Sandoval, Science and Education Administration, Agricultural Research.)

This soil is suited to only the most salt tolerant trees and shrubs. The seedling survival rate is poor, and the vigor, density, and height of the surviving trees are severely restricted.

This soil is poorly suited to septic tank absorption fields and building site development. The wetness is the main limitation. Also, the moderately slow permeability is a limitation in septic tank absorption fields and the shrink-swell potential a limitation on sites for most buildings. A drainage system reduces the wetness in septic tank absorption fields and helps to prevent seepage into basements, but the seasonal high water table is a continuing limitation. The slow absorption of liquid waste in the absorption fields can be overcome by enlarging the field. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The capability subclass is IIIs.

401—Aberdeen-Nutley silty clays. These deep, level soils are on glacial lake plains. The moderately well drained, alkali Aberdeen soil is on broad flats, and the well drained Nutley soil is on the slightly higher lying plane and convex slopes. Individual areas range from 5 to about 400 acres. They are about 65 percent Aberdeen soil and 30 percent Nutley soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the Aberdeen soil has a black silty clay surface layer about 8 inches thick. The subsoil is about 31 inches of very dark grayish brown silty clay and clay. In the lower part it is mottled and has masses of gypsum crystals. The substratum to a depth of about 60 inches is calcareous, light brownish gray, mottled clay. In places the surface layer is silty clay loam.

Typically, the Nutley soil has a black silty clay surface layer about 9 inches thick. The subsoil is about 14 inches thick. It is very dark grayish brown silty clay in the upper part and dark grayish brown and very dark grayish brown, mottled clay in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay. In places, the soil is moderately well drained and the surface soil is more than 9 inches thick. In some areas the soil contains less clay.

Included with these soils in mapping are small areas of the somewhat poorly drained, alkali Exline soils, which make up 1 to 5 percent of the unit. These included soils have visible salts within a depth of 16 inches.

The Aberdeen and Nutley soils are slowly permeable. Available water capacity is high in the Aberdeen soil and moderate in the Nutley soil. Runoff is slow on the Aberdeen soil and medium on the Nutley soil. A seasonal high water table is at a depth of 4 to 6 feet in the Aberdeen soil. The shrink-swell potential is high in both soils. The dense subsoil of the Aberdeen soil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, sugar beets, and potatoes. The moderate alkalinity and dense subsoil of the Aberdeen soil and the poor workability of both soils are the main limitations. Other management concerns are soil blowing and moisture stress, which restricts crop growth on the Aberdeen soil in most years. Including deep rooted legumes in the cropping sequence helps to loosen the dense subsoil and improves tilth. Tilling these soils is difficult. Tilth easily deteriorates because of the high content of clay. Tilling at the proper moisture content helps to prevent surface compaction and the destruction of soil structure. Returning crop residue to the soil, planting green manure crops, and applying barnyard manure improve soil structure. Field windbreaks, stripcropping, buffer strips, and cover crops help to control soil blowing. Leaving crop residue on the surface throughout the winter helps to control soil blowing on fall tilled fields.

A cover of hay or pasture plants is effective in controlling soil blowing and improving tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

These soils are suited to many of the trees and shrubs commonly grown as windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for septic tank absorption fields and buildings. The slow absorption of liquid waste is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The high shrink-swell potential is a limitation on building sites. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling. The wetness in the Aberdeen soil is a limitation on sites for dwellings with basements. Subsurface drains help to prevent seepage into basements.

The capability subclass is IIIs.

402—Exline-Aberdeen silty clays. These deep, level, alkali soils are on broad flats on glacial lake plains. The somewhat poorly drained Exline soil is in the lower lying concave areas. The moderately well drained Aberdeen soil in the slightly higher areas. Individual areas range from about 5 to more than 300 acres. They are about 65 percent Exline soil and 30 percent Aberdeen soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Exline soil is black silty clay about 8 inches thick. It contains salt crystals. The subsoil is about 18 inches of clay that contains salt crystals. It is black in the upper part and very dark gray in the lower part. The upper part of the substratum is calcareous, dark grayish brown, light brownish gray, and grayish brown, mottled clay about 14 inches thick. The next part is light olive brown, mottled clay loam. The lower part to a depth of about 60 inches is olive brown, mottled silty clay loam. In places the surface layer is silty clay loam.

Typically, the surface layer of the Aberdeen soil is black silty clay about 8 inches thick. The subsoil is about 31 inches of very dark grayish brown silty clay and clay.

In the lower part it is mottled and has masses of gypsum crystals. The substratum to a depth of about 60 inches is calcareous, light brownish gray, mottled clay. In places the surface layer is silty clay loam.

Included with these soils in mapping are small areas of the well drained Nutley soils, which make up 1 to 10 percent of the unit. These included soils are on the higher lying plane and convex slopes. They are nonalkali.

Permeability is very slow in the Exline soil and slow in the Aberdeen soil. Available water capacity is moderate in the Exline soil and high in the Aberdeen soil. Runoff is very slow on the Exline soil and slow on the Aberdeen soil. A seasonal high water table is at a depth of 2.5 to 4 feet in the Exline soil and 4 to 6 feet in the Aberdeen soil. The shrink-swell potential is high in both soils. The dense subsoil in both restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. These soils are unsuited to most cultivated crops and to pasture and hay because of the severe alkalinity, the dense subsoil, and poor workability. Other management concerns are soil blowing and moisture stress, which restricts crop growth in most years. A cover of hay or pasture plants is effective in controlling soil blowing. Growing deep rooted legumes, such as alfalfa and sweetclover, helps to loosen the dense subsoil. The areas used for grazing should be carefully managed. Proper stocking rates, pasture rotation, and timely deferment of grazing are needed.

The Aberdeen soil is suited to many of the trees and shrubs commonly grown as windbreaks and environmental plantings, but the Exline soil generally is unsuited because moisture stress is severe in most years. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are suitable as sites for buildings. The shrink-swell potential is the main limitation. Also, the wetness is a limitation on sites for dwellings with basements. Subsurface drains help to prevent seepage into basements. Installing surface and foundation drains and reinforcing basement and foundation walls help to prevent the structural damage caused by shrinking and swelling.

The Aberdeen soil is suitable as a septic tank absorption field. The Exline soil is unsuitable, however, because it is very slowly permeable and is wet. The slow permeability of the Aberdeen soil is a limitation, but it can be overcome by enlarging the absorption field.

The capability subclass is VIs.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

Edward Weimer, agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1977, about 451,100 acres in Grand Forks County was used for close-grown crops, mainly wheat, barley, oats, and flaxseed. Other crops grown in 1977 were sunflowers, on 95,300 acres; potatoes, on 34,700 acres; dry edible beans, on 34,100 acres; hay, on 20,700 acres; and sugar beets, on 14,000 acres. About 103,000 acres, or 13 percent of the farmland, was summer fallowed (*12*).

Since 1967, the acreage planted to row crops has increased and the acreage planted to close-grown crops, pastured, or summer fallowed has decreased, mainly as a result of higher prices for some crops. In recent years the acreage planted to sunflowers has increased considerably.

The potential of the soils in Grand Forks County for increased production of food and fiber is good. The production could be increased by applying the latest crop production technology to all cropland in the county. This soil survey facilitates the application of this technology.

The soils and climate of the county are suited to most of the crops that are commonly grown in the area and to some that are not commonly grown, for example, buckwheat, rye, and corn.

Measures that control soil blowing and water erosion, remove excess surface water, conserve moisture, and improve fertility are the main management needs if the soils in Grand Forks County are cultivated.

Soil blowing and water erosion reduce the productivity of soils. If the surface layer is lost through soil blowing or water erosion, most of the available plant nutrients and most of the organic matter, which has positive effects on soil structure, water infiltration, available moisture capacity, and soil tilth, are also lost.

Soil blowing is a hazard on nearly all of the soils of the county. It is most severe on the coarse and moderately coarse textured Arvilla, Embden, Hecla, Inkster, Maddock, and Towner soils. It can damage these soils in a very short time if winds are strong and the soils are dry and lack a protective cover of plants or mulch. Water erosion is a hazard mainly on the moderately sloping and steeper Barnes, Buse, and Kloten soils. Measures that

control runoff help to prevent excessive soil loss in many areas of these soils.

Among the measures that help to control both soil blowing and water erosion are cover crops, stripcropping, buffer strips, windbreaks, diversions and grassed waterways, minimum tillage, timely and emergency tillage, grasses and legumes in the cropping sequence, and crop residue management. A combination of several measures generally is used.

Excess surface water collects on many soils in the spring and during periods of heavy rainfall. Draining somewhat poorly drained to very poorly drained soils generally increases productivity and the number of suitable crops. A system of constructed drains and road ditches helps to remove excess surface water from many areas of Bearden and Glyndon soils. On Parnell, Vallers, and other soils, however, suitable outlets generally are not available.

Measures that conserve moisture are needed on soils that tend to be droughty. They decrease evaporation and runoff rates, increase the infiltration rate, and control weeds. Some of the effective measures are stubble mulching, stripcropping, field windbreaks and buffer strips, timely tillage, minimum tillage, grasses and legumes in the cropping sequence, a cover of crop residue, and applications of fertilizer. Fallowing helps to control weeds and thus conserves available moisture.

Measures that improve fertility are needed on some soils. Examples are applying fertilizer, plowing green manure and barnyard manure under, including cover crops, grasses, and legumes in the cropping sequence, and summer fallowing. Most of the measures that help to control soil blowing and water erosion also improve fertility.

The most commonly used conservation measures, for example, growing green manure crops and including grasses and legumes in the cropping sequence, help to keep the soil in good tilth. Fall plowing at the right moisture content helps to keep clayey soils, such as Nutley and Wahpeton soils, in good tilth and helps in preparing a good seedbed.

Some stone removal generally is needed on soils that formed in till. Barnes, Buse, and Svea soils are examples.

Further information about the management and crops described in this section can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

saline soils

D. D. Patterson, Soils Department, North Dakota State University, prepared this section.

Areas of salt-affected soils make up about 23 percent of the total acreage of Grand Forks County. These dominantly are areas of Bearden silty clay loam, saline; Ojata silty clay loam; Antler silty clay loam, saline; Vallers-Manfred clay loams, saline; and Antler-Tonka silty clay loams, saline. Small areas of other saline soils are throughout the county.

Plants growing on saline soils absorb salts from the soil solution. Excess amounts of certain salts may interfere with plant metabolism or vital growth processes. High concentrations of some salts are toxic to certain plants. Other salts may cause nutritional imbalances or deficiencies by restricting the uptake or availability of essential plant nutrients.

Detecting salinity by visual observation in the field is difficult. The salts are not visible during much of the growing season because of moisture in the soil. The flecks, threads, or masses of soluble salts are visible only when the soil is dry (fig. 10).

Saline soils have a layer of accumulated lime within 16 inches of the surface. If the soils have been plowed, part of the lime zone has been mixed with the black surface soil. The soils are grayer when dry. Surface color, however, does not necessarily indicate a high concentration of salts. Laboratory analysis is needed to determine the actual salinity of areas within the same field that are similar in surface color.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the degree of salinity. For instance, small grain growing on saline soils tends to be stunted, to have shorter stems, smaller leaves, fewer tillers, and shorter seed heads than small grain on nonsaline soils. If crops are grown in fields where the degree of salinity varies, the plants vary in height. In some areas severe salinity prevents crop growth.

A measure of the effect of soil salinity on vegetative growth is not necessarily a reliable measure of crop yields. Yields of barley and wheat seeds, for example, generally are decreased less than the vegetative growth is decreased. Yields of storage roots in sugar beets and potatoes commonly are reduced more than the vegetative growth of fibrous roots or tops (*10*).

The field crops and forage plants commonly grown in the county are grouped in this paragraph according to relative salt tolerance. The degree of tolerance declines from first to last in each group, but a difference in ranking of two or three places probably is not significant (*3, 8, 10, 11, 15*). Of the field crops, none exhibit high tolerance; sugar beets (after emergence), barley, safflower, rape, rye, oats, and wheat exhibit moderate tolerance; and soybeans, corn, sunflowers, flax, potatoes, field peas, and field beans exhibit low tolerance. Of the forage crops, tall wheatgrass, tall fescue, slender wheatgrass, Russian wildrye, and western wheatgrass exhibit high tolerance; sweetclover, sudangrass, millet, alfalfa (once established), crested wheatgrass, smooth bromegrass, intermediate wheatgrass, Canada wildrye, and reed canarygrass exhibit moderate tolerance; and alfalfa seedlings exhibit low tolerance.

Trees and shrubs also exhibit varying degrees of tolerance to soil salinity. The growth and survival of

seedlings and transplants of evergreen and deciduous trees are restricted on slightly saline soils (*11*). Figure 11 illustrates the effect of salinity on trees in a shelterbelt in Grand Forks County. The shelterbelt consisted of 10 rows of Russian-olive, eastern redcedar, green ash, Siberian elm, cottonwood, and boxelder. Russian-olive, the most salt tolerant species, grew well on a slightly saline soil. On a strongly saline soil, however, it did not survive or growth was severely restricted (*13*).

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

Figure 11.—Windbreaks on Bearden silty clay loam, saline. (Photo courtesty of F. M. Sandoval, Science and Education Administration, Agricultural Research.)

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

native woodland, windbreaks, and environmental plantings

Elmer R. Umland, forester, Soil Conservation Service, helped prepare this section.

About 12,700 acres of Grand Forks County is woodland. The early settlers used the trees for lumber, fenceposts, and fuel. Today, very little of the woodland is used for these purposes. The woodland is valued primarily for livestock protection, wildlife habitat, recreation, esthetic value, and watershed protection.

About 80 percent of the woodland is on upland side slopes and the flood plains along the Red River of the North and its principal tributaries, the Turtle, Goose, and Forest Rivers. Cashel, LaDelle, Velva, and Wahpeton soils commonly support the trees and shrubs in these areas. About 20 percent of the woodland is on the side slopes and breaks of these drainageways. Arvilla, Buse, Hecla, Maddock, Sioux, Svea, and Zell soils commonly support the trees and shrubs in these areas.

The principal species of trees and shrubs in the county are American elm, green ash, boxelder, American basswood, bur oak, eastern cottonwood, common chokecherry, American plum, silver buffaloberry, redosier dogwood, golden currant, woods rose, willow, and several species of hawthorne. Green ash and bur oak are dominant on the side slopes and breaks of the drainageways and cottonwood, American elm, and boxelder on the flood plains.

Windbreaks have been planted in Grand Forks County since the days of the first settlers. Most of the early windbreaks protected farmsteads and feedlots. On about 3,400 acres trees and shrubs were planted in the late 1930's, under the Prairie States Forestry Project of the U.S. Department of Agriculture, Forest Service. Since that time, local farmers have planted nearly 7,000,000 trees and shrubs on more than 9,000 acres. Windbreaks are still needed around many of the farmsteads, but the major need is in cultivated areas where soil blowing is a hazard.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, keep snow from blowing off the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil

Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Erling Podoll and James Schmidt, biologists, Soil Conservation Service, helped prepare this section.

Turtle River State Park is the only major recreational area in Grand Forks County. The sites for several watershed protection dams are being developed for recreational activities, including picnicking, swimming, and ball playing.

The development of recreational areas will be an important factor in the future growth of Grand Forks County. Scenic areas are along the major rivers. If these areas are developed for recreational uses, measures that protect permanent structures from floodwater are needed. Of the soil associations described under the heading "General soil map units," the Embden-Inkster and Arvilla-Hecla associations have the best potential for recreational development.

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

wildlife habitat

Erling Podoll and James Schmidt, biologists, Soil Conservation Service, prepared this section.

Grand Forks County has a small but varied population of fish and wildlife. White-tailed deer, white-tailed jackrabbit, gray partridge, striped skunk, red fox, and songbirds are among the principal openland wildlife species in the county. Beaver, muskrat, geese, ducks, and shore birds are the most common species on the wetlands. The most commonly caught fish are walleye, northern pike, catfish, and perch.

The extent of wildlife habitat is very limited in the county. The Prairie Chicken State Game Management Area provides openland wildlife habitat. It is managed specifically for the greater prairie chicken. Wooded areas along streams and coulees provide some natural cover for openland wildlife. Farmstead shelterbelts, field windbreaks, wildlife habitat plantings, abandoned farmsteads, and gravel pits provide additional cover in cropped areas.

About 246,900 acres in the county is drained wetland type 1 (wet meadow) to type 5 (open freshwater). An estimated 59,500 acres of wetland types 1 to 5 is used for wetland habitat. Wetland types 4 and 5 include areas of inland saline marshes and open saline water in the Ojata association, which is described under the heading "General soil map units." Kelly Slough National Wildlife

Refuge and the adjacent National Waterfowl Production Area are managed for wetland wildlife and migratory waterfowl, but they also include a significant acreage of the openland wildlife habitat in the county.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are tall wheatgrass, bromegrass, sweetclover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are little bluestem, goldenrod, green needlegrass, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are juneberry, dogwood, hawthorn, and snowberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cordgrass, bulrushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for openland and wetland wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, meadowlark, sharp-tailed grouse, jackrabbit, and red fox.

Habitat for wetland wildlife consists of open or marshy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations.

For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

sanitary facilities

Table 10 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site

features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil

properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by toxic substances in the root zone, such as salts or sodium. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 16.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 or 20 percent, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*):

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and

sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

soil and water features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in marshes are not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the

water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series. The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*16*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that have a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has a udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*14*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*16*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Aberdeen series

The Aberdeen series consists of deep, moderately well drained, slowly permeable, alkali soils on glacial lake plains. These soils formed in fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

The Aberdeen soils in this survey area contain more clay in the surface layer than is defined as the range for the Aberdeen series. Also, they do not have tongues of albic material. These differences, however, do not alter the use or behavior of the soils.

Aberdeen soils are similar to Cresbard soils and are commonly adjacent to Exline and Nutley soils on the

landscape. Cresbard soils contain more sand than the Aberdeen soils. They formed in till. Exline soils are somewhat poorly drained. They have visible salts within a depth of 16 inches. Nutley soils do not have a natric horizon. They are well drained.

Typical pedon of Aberdeen silty clay, in an area of Aberdeen-Nutley silty clays, 2,115 feet east and 75 feet north of the southwest corner of sec. 31, T. 153 N., R. 55 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate fine granular; very hard, firm, sticky and plastic; common very fine roots; neutral; abrupt smooth boundary.

B21t—8 to 16 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate fine and medium angular blocky; very hard, firm, sticky and plastic; few very fine roots; very dark gray (10YR 3/1) organic stains on faces of peds; much uncoated or clean silt or very fine sand on faces of peds; mildly alkaline; clear irregular boundary.

B22t—16 to 27 inches; very dark grayish brown (2.5Y 3/2) clay, grayish brown (2.5Y 5/2) dry; strong medium prismatic structure parting to moderate fine and medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; thin continuous clay films on faces of peds; strong effervescence; moderately alkaline; clear smooth boundary.

B3cs—27 to 39 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine distinct black (5Y 2/2) mottles; moderate medium prismatic structure parting to moderate fine and medium angular blocky; very hard, firm, sticky and plastic; few very fine roots; thin continuous clay films on faces of peds; common fine and medium segregated masses of gypsum crystals; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cca—39 to 60 inches; light brownish gray (2.5Y 6/2) clay, white (2.5Y 8/2) dry; many fine and medium prominent reddish brown (5YR 4/4) and few fine distinct dark olive gray (5Y 3/2) mottles; massive; very hard, firm, sticky and plastic; disseminated lime throughout; violent effervescence; strongly alkaline.

The thickness of the solum ranges from 19 to 48 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B2t horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It typically is clay and silty clay, but the range includes silty clay loam. The C horizon typically is clay but in some pedons has strata of silty clay loam and silt loam.

Antler series

The Antler series consists of deep, somewhat poorly drained, moderately slowly permeable soils in areas between beach ridges. These soils formed in glaciolacustrine deposits overlying till. Slope is 0 to 1 percent.

Antler soils are similar to Gilby and Hamerly soils and are commonly adjacent to Gilby, Svea, Tonka, and Vallers soils on the landscape. Gilby soils contain less clay in the upper part of the control section than the Antler soils. Hamerly soils contain more sand in the upper part than the Antler soils. Svea and Tonka soils do not have a calcic horizon within a depth of 16 inches. Also, the poorly drained Tonka soils contain more clay than the Antler soils. The poorly drained Vallers soils are on low lying flats and in seepy areas.

Typical pedon of Antler silt loam, in an area of Antler-Tonka silt loams, 835 feet west and 625 feet north of the southeast corner of sec. 2, T. 149 N., R. 51 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium angular blocky structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1ca—9 to 18 inches; gray (N 5/0) silt loam; light gray (N 6/0) dry; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; tongues of black (10YR 2/1) material throughout; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—18 to 29 inches; light olive brown (2.5Y 5/4) silty clay loam, light gray (2.5Y 7/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; about 2 percent pebbles; few fine masses of gypsum crystals; disseminated lime throughout; violent effervescence; moderately alkaline; gradual smooth boundary.

IIC3—29 to 42 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; common fine distinct brownish yellow (10YR 6/6) and common medium distinct gray (10YR 6/1) mottles; massive; very hard, firm, sticky and plastic; about 5 percent pebbles; thin cobble line in the upper part; common medium masses of gypsum crystals; slight effervescence; mildly alkaline; clear wavy boundary.

IIC4—42 to 60 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 7/4) dry; common fine distinct gray (10YR 6/1) and strong brown (7.5YR 5/6) mottles; massive; very hard, firm, sticky and plastic; about 5 percent pebbles; slight effervescence; mildly alkaline.

These soils typically are nonsaline, but some pedons are slightly or moderately saline. The thickness of the

mollic epipedon ranges from 7 to 16 inches. The depth to till ranges from 17 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is silt loam or silty clay loam. The Cca horizon has hue of neutral or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 4 or less. The IIC horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 1 to 4. In most pedons as much as 6 inches of sand, gravel, or cobbles is at the upper boundary of the IIC horizon.

Arveson series

The Arveson series consists of deep, poorly drained, moderately rapidly permeable soils on beaches and delta plains. These soils are deep or moderately deep over sand. They formed in medium textured and moderately coarse textured sediments overlying coarse textured glaciofluvial and glaciolacustrine deposits. Slope is 0 to 1 percent.

Arveson soils are similar to Borup and Rockwell soils and are commonly adjacent to Embden, Hecla, Tiffany, and Wyndmere soils on the landscape. Borup soils contain less sand than the Arveson soils. Rockwell soils have a IIC horizon of till or glaciolacustrine deposits within a depth of 40 inches. Embden, Hecla, and Tiffany soils do not have a calcic horizon within a depth of 16 inches. Also, Hecla soils contain less clay than the Arveson soils. Wyndmere soils are somewhat poorly drained.

Typical pedon of Arveson loam, 1,970 feet north and 1,750 feet east of the southwest corner of sec. 1, T. 152 N., R. 55 W.

Ap—0 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

A12ca—11 to 15 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—15 to 30 inches; dark gray (5Y 4/1) sandy loam, light gray (5Y 6/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—30 to 41 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

IIC3—41 to 50 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few fine segregated soft masses of lime; slight effervescence; moderately alkaline; clear wavy boundary.

IIC4—50 to 60 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. The Cca horizon has hue of 2.5Y, 5Y, or neutral, value of 3 to 7 (5 to 8 dry), and chroma of 2 or less. It typically is sandy loam, but the range includes loam and sandy clay loam. The IIC horizon typically is sand, but the range includes coarse sand and loamy sand. Some pedons do not have a IIC horizon. Some pedons have strata of till or glaciolacustrine deposits below a depth of 40 inches.

Arvilla series

The Arvilla series consists of deep, somewhat excessively drained, rapidly permeable soils on delta plains and beaches. These soils are shallow or moderately deep over sand and gravel. They formed in moderately coarse textured sediments overlying coarse textured glaciofluvial and glaciolacustrine deposits. Slope ranges from 1 to 6 percent.

Arvilla soils are similar to Renshaw soils and are commonly adjacent to Embden, Sioux, and Wyndmere soils on the landscape. Renshaw soils contain more clay in the solum than the Arvilla soils. Embden and Wyndmere soils contain more clay than the Arvilla soils. Also, Wyndmere soils have a calcic horizon within a depth of 16 inches. Sioux soils do not have a B horizon and are very shallow and shallow over sand and gravel.

Typical pedon of Arvilla sandy loam, 1 to 6 percent slopes, 1,450 feet east and 140 feet north of the southwest corner of sec. 13, T. 152 N., R. 55 W.

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular and subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

B2—7 to 18 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent pebbles in the lower part; neutral; gradual wavy boundary.

IIC2—18 to 29 inches; dark brown (10YR 3/3) sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about

5 percent pebbles; slight effervescence; moderately alkaline; clear smooth boundary.

IIC3—29 to 60 inches; brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots in the upper 6 inches; about 25 percent pebbles; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 19 inches. The thickness of the solum, or the depth to the IIC horizon, ranges from 14 to 22 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The IIC horizon typically is sand and gravelly coarse sand but in some pedons is loamy sand. It is 5 to 35 percent gravel.

Barnes series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in medium textured and moderately fine textured till. Slope ranges from 1 to 15 percent.

Barnes soils are similar to Edgeley soils and are commonly adjacent to Buse, Cresbard, Hamerly, Sioux, and Svea soils on the landscape. Edgeley soils have a IICr horizon of shale. Buse soils do not have a B horizon. Cresbard soils have a natric horizon. Hamerly soils are somewhat poorly drained. They have a calcic horizon within a depth of 16 inches. Sioux soils do not have a B horizon and are very shallow and shallow over sand and gravel. Svea soils have a mollic epipedon that is more than 16 inches thick.

Typical pedon of Barnes loam, 3 to 6 percent slopes, 200 feet east and 25 feet south of the northwest corner of sec. 5, T. 151 N., R. 56 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular and weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent pebbles; mildly alkaline; abrupt smooth boundary.

A12—7 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine prismatic structure parting to weak fine and medium subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; about 5 percent pebbles; mildly alkaline; abrupt smooth boundary.

B2—11 to 22 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate fine prismatic structure parting to weak fine and medium subangular blocky; hard, firm, slightly sticky and slightly plastic; common very fine roots; very dark grayish brown (10YR 3/2) coatings on faces of peds; about 10 percent pebbles; mildly alkaline; gradual wavy boundary.

C1ca—22 to 29 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak fine and medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; about 10 percent pebbles; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C2—29 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct light gray (2.5Y 7/2) and dark red (2.5YR 3/6) mottles; weak fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few very fine roots; about 10 percent pebbles; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 23 inches. The thickness of the mollic epipedon ranges from 7 to 16 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR, value of 2 to 4 (4 to 6 dry), and chroma of 2 to 4. It typically is loam, but the range includes clay loam. The Cca horizon has hue of 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. The C horizon typically is loam, but the range includes clay loam. Also, the lower part has thin strata of sand or gravel in some pedons.

Bearden series

The Bearden series consists of deep, somewhat poorly drained, moderately slowly permeable soils on glacial lake plains. These soils formed in medium textured and moderately fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Bearden soils are similar to Glyndon soils and are commonly adjacent to Colvin, Ojata, Overly, and Perella soils on the landscape. Glyndon soils contain less clay throughout than the Bearden soils. Colvin and Ojata soils are poorly drained. Also, Ojata soils are strongly saline. Overly and Perella soils do not have a calcic horizon within a depth of 16 inches.

Typical pedon of Bearden silty clay loam, 2,000 feet north and 550 feet east of the southwest corner of sec. 13, T. 151 N., R. 51 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak very fine subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1ca—10 to 21 inches; gray (10YR 5/1) silty clay loam, light gray (10YR 6/1) dry; weak very fine subangular blocky and weak fine granular structure; hard, friable, sticky and plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2—21 to 38 inches; light olive brown (2.5Y 5/4) silt loam, pale olive (5Y 6/3) dry; few fine prominent

dark red (2.5YR 3/6) and common fine distinct light gray (10YR 6/1) mottles; weak very fine angular and subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—38 to 51 inches; light olive brown (2.5Y 5/4) silt loam, pale olive (5Y 6/3) dry; few fine prominent dark red (2.5YR 3/6) and common fine distinct light gray (10YR 6/1) mottles; weak very fine angular and subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; mildly alkaline; abrupt wavy boundary.

C4—51 to 60 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) silty clay loam, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; few fine prominent dark reddish brown (5YR 3/4) and few fine distinct light gray (5Y 7/1) mottles; weak very fine angular blocky structure; very hard, firm, sticky and plastic; slight effervescence; mildly alkaline.

These soils typically are nonsaline, but some pedons are saline. The thickness of the mollic epipedon ranges from 8 to 15 inches.

The A horizon has hue of neutral or 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. It is silty clay loam or silty clay. In slightly or moderately saline areas, it has few to common fine salt crystals. The Cca horizon has hue of 10YR to 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. The C horizon has hue of 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It has few to many, distinct or prominent mottles. It typically is silty clay loam and silt loam, but strata of very fine sand, clay loam, and silty clay are in the lower part in some pedons.

Borup series

The Borup series consists of deep, poorly drained soils on glacial lake plains and in seepy areas. These soils formed in medium textured glaciolacustrine deposits. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Borup soils are similar to Arveson, Colvin, and Ojata soils and are commonly adjacent to Arveson, Bearden, Colvin, and Glyndon soils on the landscape. Arveson soils have a higher content of coarse sand than the Borup soils. Bearden and Colvin soils contain more clay than the Borup soils. Ojata soils have an electrical conductivity of more than 16 millimhos per cubic centimeter. Also, they contain more clay than the Borup soils. Bearden and Glyndon soils are on the higher lying plane and convex slopes and are somewhat poorly drained.

Typical pedon of Borup silt loam, 1,000 feet west and 40 feet south of the northeast corner of sec. 22, T. 150 N., R. 53 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

A12—7 to 12 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C1ca—12 to 28 inches; gray (5Y 5/1) silt loam, light gray (5Y 6/1) dry; weak fine and medium subangular blocky structure; hard, friable, sticky and plastic; tongues of very dark grayish brown (10YR 3/2) material to a depth of 18 inches; common fine and medium masses of gypsum crystals in the lower part; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—28 to 34 inches; dark gray (5Y 4/1) silt loam, light gray (10YR 6/1) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium masses of gypsum crystals; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—34 to 60 inches; grayish brown (2.5Y 5/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; common medium and coarse distinct light yellowish brown (2.5Y 6/4) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The A horizon has hue of 10YR to 5Y or neutral, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. The Cca horizon has hue of 2.5Y, 5Y, or neutral, value of 4 to 6 (5 to 7 dry), and chroma of 2 or less. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. It typically is very fine sandy loam, but the range includes silt loam, loamy very fine sand, and loam.

Buse series

The Buse series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in medium textured and moderately fine textured till. Slope ranges from 3 to 25 percent.

Buse soils are similar to Zell soils and are commonly adjacent to Barnes, Cresbard, Hamerly, and Svea soils on the landscape. Zell soils contain less sand than the Buse soils. Barnes and Svea soils have a B horizon, and

their solum is thicker than that of the Buse soils. Cresbard soils have a natric horizon. Hamerly soils are somewhat poorly drained.

Typical pedon of Buse loam, in an area of Svea-Buse loams, 1 to 6 percent slopes, 625 feet south and 245 feet west of the northeast corner of sec. 7, T. 154 N., R. 56 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine granular and angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; strong effervescence; mildly alkaline; abrupt wavy boundary.

C1ca—8 to 27 inches; light brownish gray (10YR 6/2) loam, white (10YR 8/2) dry; weak fine angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent pebbles; disseminated lime throughout; violent effervescence; moderately alkaline; clear broken boundary.

C2—27 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; common fine distinct dark reddish brown (5YR 3/3) and few fine distinct strong brown (7.5YR 5/8) mottles; weak fine angular and subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium segregated masses of lime; about 10 percent pebbles; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 5 or 6 (6 to 8 dry), and chroma of 2 or 3. The C horizon typically is clay loam, but the range includes loam.

Cashel series

The Cashel series consists of deep, somewhat poorly drained, moderately slowly permeable soils on flood plains and channeled bottom land. These soils formed in moderately fine textured alluvium. Slope ranges from 1 to 25 percent.

Cashel soils are commonly adjacent to Bearden, Dovray, LaDelle, and Wahpeton soils on the landscape. The adjacent soils have a mollic epipedon and do not have a horizon in the upper part of the pedon that is finely stratified or laminated. Also, Bearden soils have a calcic horizon within a depth of 16 inches, Dovray soils are poorly drained, and LaDelle and Wahpeton soils are moderately well drained.

Typical pedon of Cashel silty clay loam, 1 to 6 percent slopes, 1,300 feet east and 1,000 feet south of the northwest corner of sec. 28, T. 152 N., R. 50 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak very fine subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—9 to 23 inches; very dark gray (5Y 3/1) finely stratified silty clay loam, gray (5Y 5/1) dry; weak very fine subangular blocky structure; hard, firm, sticky and plastic; few fine and common very fine roots; few fine threads of lime; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1b—23 to 27 inches; black (5Y 2/1) silty clay loam, gray (5Y 5/1) dry; moderate very fine angular and subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few fine threads of lime; slight effervescence; mildly alkaline; abrupt wavy boundary.

C2—27 to 60 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; few fine distinct white (10YR 8/1) mottles; weak very fine angular and subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few fine threads of lime; slight effervescence; mildly alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. The C horizon typically is silty clay loam, but the range includes silty clay.

Cavour series

The Cavour series consists of deep, moderately well drained, slowly permeable, alkali soils on till plains. These soils formed in medium textured and moderately fine textured till. Slope ranges from 0 to 3 percent.

Cavour soils are commonly adjacent to Cresbard, Hamerly, Miranda, Parnell, and Svea soils on the landscape. Cresbard soils have a B&A horizon and do not have columnar structure in the upper part of the B2t horizon. Hamerly, Parnell, and Svea soils do not have a natric horizon. Also, Hamerly soils are somewhat poorly drained and Parnell soils very poorly drained. Miranda soils have an A horizon that is thinner than that of the Cavour soils. They have salts within a depth of 16 inches.

Typical pedon of Cavour loam, in an area of Cresbard-Cavour loams, 0 to 3 percent slopes, 2,100 feet north and 1,600 feet west of the southeast corner of sec. 20, T. 153 N., R. 56 W.

Ap—0 to 8 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches; very dark gray (10YR 3/1) loam, gray (10YR 6/1) dry; moderate very thin platy structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

B21t—12 to 21 inches; black (N 2/0) clay, dark gray (10YR 4/1) dry; moderate medium columnar structure parting to moderate very fine and fine angular blocky; extremely hard, very firm, sticky and plastic; few very fine roots; many thin and few moderately thick clay films on faces of peds; thin very dark gray (10YR 3/1) coatings on the tops of columns, gray (10YR 6/1) dry; moderately alkaline; abrupt wavy boundary.

B22t—21 to 27 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to moderate very fine and fine angular blocky; very hard, firm, sticky and plastic; few very fine roots; very few thin clay films on faces of peds; moderately alkaline; clear wavy boundary.

Ccacs—27 to 60 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; common fine and medium distinct dark brown (7.5YR 4/4) and light gray (10YR 7/1) mottles; weak very fine and fine angular blocky structure; hard, firm, sticky and plastic; common fine and medium segregated masses of lime and of gypsum crystals; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 30 inches. The Ap horizon has hue of neutral or 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. The A2 horizon has hue of 10YR, value of 3 or 4 (5 or 6 dry), and chroma of 1. It typically is loam, but the range includes silt loam. The B horizon has hue of neutral, 10YR, or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 2 or less. The Ccacs horizon has hue of 2.5Y, value of 4 or 5 (5 to 8 dry), and chroma of 2 to 4.

Colvin series

The Colvin series consists of deep, poorly drained, moderately slowly permeable soils on glacial lake plains and in seepy areas. These soils formed in medium textured and moderately fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Colvin soils are similar to Borup and Ojata soils and are commonly adjacent to Bearden, Ojata, Overly, and Perella soils on the landscape. Borup soils contain less clay throughout than the Colvin soils. Ojata soils are strongly saline. Bearden soils are somewhat poorly drained. Overly and Perella soils do not have a calcic horizon within a depth of 16 inches.

Typical pedon of Colvin silty clay loam, 2,640 feet west and 520 feet north of the southeast corner of sec. 16, T. 151 N., R. 50 W.

Ap—0 to 11 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak very fine and fine subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—11 to 21 inches; dark gray (5Y 4/1) and gray (5Y 5/1) silty clay loam, gray (5Y 5/1 and 5Y 6/1) dry; few fine distinct olive brown (2.5Y 4/4) mottles; weak very fine subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2g—21 to 35 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; weak very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

C3g—35 to 49 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; common fine distinct dark yellowish brown (10YR 4/4) and gray (N 6/0) mottles; weak very fine angular and subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots to 40 inches; strong effervescence; mildly alkaline; clear wavy boundary.

C4g—49 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; few medium prominent dark reddish brown (5YR 3/4) and few medium distinct brownish yellow (10YR 6/6) and gray (5Y 5/1) mottles; weak very fine angular blocky structure; hard, friable, sticky and plastic; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of neutral or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. The Cca horizon has hue of neutral or 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 or less. It typically is silty clay loam, but the range includes silt loam. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 3. It has few to many, distinct or prominent mottles. It typically is silt loam and silty clay loam, but in some pedons it has strata of very fine sand, very fine sandy loam, clay loam, and clay in the lower part.

Cresbard series

The Cresbard series consists of deep, moderately well drained, moderately slowly permeable, alkali soils on till plains. These soils formed in medium textured and moderately fine textured till. Slope ranges from 0 to 6 percent.

Cresbard soils are similar to Aberdeen soils and are commonly adjacent to Barnes, Buse, Cavour, Hamerly, Miranda, and Svea soils on the landscape. Aberdeen soils formed in glaciolacustrine deposits. They contain less sand than the Cresbard soils. Barnes, Buse, Hamerly, and Svea soils do not have a natric horizon.

Cavour soils do not have a B&A horizon and have columnar structure in the upper part of the B2t horizon. Miranda soils have an A horizon that is thinner than that of the Cresbard soils. They have visible salts within a depth of 16 inches.

Typical pedon of Cresbard loam, in an area of Cresbard-Cavour loams, 0 to 3 percent slopes, 2,100 feet south and 2,000 feet west of the northeast corner of sec. 29, T. 153 N., R. 56 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; medium acid; abrupt smooth boundary.

A2—8 to 10 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; medium acid; abrupt smooth boundary.

B&A—10 to 12 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to moderate very fine and fine angular blocky; hard, firm, sticky and plastic (B2t); very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic (A2); common very fine roots; slightly acid; clear wavy boundary.

B2t—12 to 22 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong fine angular blocky; hard, firm, sticky and plastic; few very fine roots; black (N 2/0) organic stains on faces of peds; slightly acid; abrupt wavy boundary.

C1ca—22 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to moderate very fine and fine angular blocky; hard, friable, sticky and plastic; few very fine roots; few fine filaments of lime and disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C2ca—28 to 42 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct red (10R 4/6) and common fine distinct light olive brown (2.5Y 5/4) mottles; moderate very fine and fine angular blocky structure; hard, friable, sticky and plastic; few very fine roots; common fine masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—42 to 60 inches; grayish brown (2.5Y 5/2) and dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct red (10R 4/6) and few fine distinct gray (N 5/0) mottles; moderate very fine and fine angular blocky structure; hard, friable, sticky and plastic; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 16 to 30 inches. The Ap horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The A2 horizon has hue of 10YR, value of 3 or 4 (5 or 6 dry), and chroma of 1. It typically is loam, but the range includes silt loam. In some cultivated areas the A2 and B&A horizons do not occur. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 or 3. It typically is clay loam, but the range includes loam.

Divide series

The Divide series consists of deep, somewhat poorly drained soils that are moderately permeable in the upper part and are very rapidly permeable in the lower part of the substratum. These soils are on delta plains and beaches. They are moderately deep over sand and gravel. They formed in medium textured and moderately fine textured sediments overlying coarse textured glaciofluvial and glaciolacustrine deposits. Slope ranges from 1 to 3 percent.

Divide soils are similar to Marysland soils and are commonly adjacent to Arveson, Marysland, and Renshaw soils on the landscape. Arveson and Marysland soils are poorly drained. Also, Arveson soils contain less clay in the upper part than the Divide soils. Renshaw soils do not have a calcic horizon within a depth of 16 inches. They are somewhat excessively drained.

Typical pedon of Divide loam, 1 to 3 percent slopes, 2,100 feet north and 2,300 feet east of the southwest corner of sec. 15, T. 153 N., R. 54 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent pebbles; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—10 to 16 inches; grayish brown (10YR 5/2) loam, gray (10YR 6/1) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard, very friable, sticky and plastic; few very fine roots; about 2 percent pebbles; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—16 to 25 inches; light brownish gray (10YR 6/2) gravelly clay loam, light gray (10YR 7/2) dry; massive; slightly hard, very friable, sticky and plastic; few very fine roots; about 25 percent pebbles; thin coating of lime on pebbles; violent effervescence; moderately alkaline; clear irregular boundary.

IIC3—25 to 30 inches; light olive brown (2.5Y 5/4) gravelly sand, light yellowish brown (2.5Y 6/4) dry; massive; loose, nonsticky and nonplastic; about 20

percent pebbles; strong effervescence; moderately alkaline; clear wavy boundary.

IIC4—30 to 42 inches; brown (10YR 5/3) sand, pale brown (10YR 6/3) dry; few fine distinct pink (7.5YR 7/4) and brownish yellow (10YR 6/6) mottles; massive; loose, nonsticky and nonplastic; about 2 percent pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC5—42 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light gray (2.5Y 7/2) dry; common medium prominent dark reddish brown (5YR 2.5/2) and common fine distinct strong brown (7.5YR 5/8) mottles; massive; loose, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 or 2. The IIC horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4.

Dovray series

The Dovray series consists of deep, poorly drained, very slowly permeable soils on flood plains, glacial lake plains, and till plains. These soils formed in fine textured glaciolacustrine deposits and alluvium. Slope is 0 to 1 percent.

Dovray soils are commonly adjacent to Bearden, Cashel, and Perella soils on the landscape. The adjacent soils contain less clay throughout than the Dovray soils. Bearden and Cashel soils are somewhat poorly drained. Bearden soils have a calcic horizon within a depth of 16 inches, and Cashel soils do not have a mollic epipedon. Perella soils have a mollic epipedon that is thinner than that of the Dovray soils.

Typical pedon of Dovray clay, 185 feet south and 80 feet east of the northwest corner of sec. 30, T. 154 N., R. 55 W.

Ap—0 to 6 inches; black (N 2/0) clay, dark gray (N 4/0) dry; moderate fine granular and very fine subangular blocky structure; very hard, firm, very sticky and very plastic; common very fine roots; slightly acid; abrupt smooth boundary.

A12g—6 to 14 inches; black (5Y 2/1) clay, dark gray (5Y 4/1) dry; moderate fine angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; slightly acid; abrupt smooth boundary.

A13g—14 to 51 inches; black (5Y 2/1) clay, dark gray (5Y 4/1) dry; few fine prominent reddish brown (5YR 4/4) mottles; weak very fine subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine roots; neutral; abrupt wavy boundary.

IICg—51 to 60 inches; gray (5Y 5/1) silt loam, light gray (5Y 7/1) dry; many coarse distinct very dark grayish brown (10YR 3/2) and few fine distinct dark reddish brown (5YR 3/2) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral.

The thickness of the mollic epipedon ranges from 24 to 52 inches. The A horizon has hue of neutral, 10YR, or 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. It has few to many, distinct or prominent mottles in the lower part. Some pedons do not have a IIC horizon.

Edgeley series

The Edgeley series consists of moderately deep, well drained, moderately permeable soils on till plains. These soils formed in medium textured and moderately fine textured till overlying shale. Slope ranges from 6 to 15 percent.

Edgeley soils are similar to Barnes soils and are commonly adjacent to Barnes, Buse, Cavour, Kloten, Miranda Variant, and Svea soils on the landscape. Barnes, Buse, Cavour, and Svea soils do not have a IICr horizon. Buse soils do not have a B horizon. Svea soils have a mollic epipedon that is thicker than that of the Edgeley soils. Cavour and Miranda Variant soils have a natric horizon. Kloten soils have a lithic contact within a depth of 20 inches.

Typical pedon of Edgeley loam, in an area of Edgeley-Kloten loams, 6 to 25 percent slopes, 500 feet north and 320 feet west of the center of sec. 6, T. 152 N., R. 56 W.

A1—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; about 7 percent pebbles; mildly alkaline; abrupt wavy boundary.

B1—6 to 14 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to weak very fine subangular blocky and weak fine granular; slightly hard, friable, sticky and plastic; common very fine and few fine roots; about 15 percent pebbles; strong effervescence; moderately alkaline; clear wavy boundary.

B2—14 to 25 inches; very dark grayish brown (2.5Y 3/2) shaly clay loam, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to weak very fine subangular blocky; hard, friable, sticky and plastic; few very fine and medium roots; about 30 percent pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.

B3—25 to 36 inches; dark olive gray (5Y 3/2) and olive gray (5Y 4/2) shaly clay loam, light olive gray (5Y 6/2) dry; weak very fine subangular blocky structure;

hard, friable, sticky and plastic; few very fine and medium roots; about 30 percent pebbles; common fine and medium segregated masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

IICr—36 to 60 inches; dark gray (5Y 4/1) and gray (5Y 5/1) weathered shale; few very fine roots, vertically oriented along fractures; dark brown (7.5YR 4/4) stains on faces of shale.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to shale ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR to 5Y, value of 3 or 4 (4 to 6 dry), and chroma of 1 to 3. It typically is clay loam and shaly clay loam, but the range includes shaly loam and loam.

Embden series

The Embden series consists of deep, moderately well drained, moderately rapidly permeable soils on delta plains and beaches. These soils formed in moderately coarse textured glaciofluvial and glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Embden soils are similar to Inkster soils and are commonly adjacent to Arveson, Tiffany, and Wyndmere soils on the landscape. Inkster soils have a sand fraction that is dominantly weathered shale particles. Arveson and Wyndmere soils have a calcic horizon within a depth of 16 inches. Tiffany soils are poorly drained.

Typical pedon of Embden fine sandy loam, 1 to 6 percent slopes, 2,265 feet east and 500 feet north of the southwest corner of sec. 2, T. 151 N., R. 55 W.

Ap—0 to 11 inches; black (N 2/0) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; neutral; abrupt smooth boundary.

B2—11 to 22 inches; very dark gray (10YR 3/1) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to weak fine subangular blocky and granular; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; neutral; clear wavy boundary.

C1—22 to 35 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak fine granular and subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; moderately alkaline; gradual wavy boundary.

C2—35 to 50 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; moderately alkaline; gradual wavy boundary.

C3—50 to 60 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/8) and gray (10YR 6/1) mottles; weak medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has hue of neutral or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. It is fine sandy loam or sandy loam. The B horizon has hue of 10YR, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It typically is fine sandy loam, but the range includes sandy loam and loam. Some pedons have a Cca horizon. The C horizon typically is fine sandy loam, but the range includes sandy loam and loamy fine sand. Also, the lower part has strata of sand, fine sand, or loamy sand in some pedons.

Exline series

The Exline series consists of deep, somewhat poorly drained, very slowly permeable, alkali soils on glacial lake plains. These soils formed in fine textured and moderately fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Exline soils are similar to Miranda soils and are commonly adjacent to Aberdeen and Nutley soils on the landscape. Miranda soils formed in till. Aberdeen soils are moderately well drained. They do not have visible salts within a depth of 16 inches. Nutley soils do not have a natric horizon. They are well drained.

Typical pedon of Exline silty clay, in an area of Exline-Aberdeen silty clays, 1,700 feet south and 180 feet west of the northeast corner of sec. 7, T. 152 N., R. 55 W.

Apsa—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine and medium subangular and angular blocky structure; very hard, friable, sticky and plastic; few very fine roots; common fine and medium salt crystals; thin platy gray (10YR 5/1) coatings on soil surface; neutral; abrupt smooth boundary.

B2tcssa—8 to 21 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; weak medium and coarse prismatic structure parting to weak fine and medium subangular and angular blocky; very hard, firm, sticky and plastic; few very fine roots; shiny coatings on faces of peds; common fine salt crystals; common fine and medium gypsum crystals; mildly alkaline; clear irregular boundary.

B3cssa—21 to 26 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; weak medium and coarse prismatic structure parting to weak fine and medium subangular and angular blocky; hard, firm,

very sticky and very plastic; few very fine roots; common fine salt crystals; many fine and medium gypsum crystals; slight effervescence; moderately alkaline; clear irregular boundary.

C1ca—26 to 35 inches; dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) and light gray (2.5Y 7/2) dry; few fine distinct light olive gray (2.5Y 5/4) mottles; weak fine and medium subangular and angular blocky structure; soft, friable, sticky and plastic; disseminated lime throughout; violent effervescence; moderately alkaline; clear irregular boundary.

C2ca—35 to 40 inches; grayish brown (2.5Y 5/2) clay, light brownish gray (2.5Y 6/2) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular and angular blocky structure; soft, friable, sticky and plastic; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C3—40 to 55 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct yellowish brown (10YR 5/6) and light yellowish brown (10YR 6/4) and common medium distinct light brownish gray (10YR 6/2) mottles; weak fine and medium subangular and angular blocky structure; slightly hard, friable, sticky and plastic; violent effervescence; moderately alkaline; clear wavy boundary.

C4—55 to 60 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct yellowish brown (10YR 5/6) and common fine and medium distinct grayish brown (2.5Y 5/2) mottles; massive; slightly hard, friable, sticky and plastic; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 7 to 28 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. Some pedons have an A2 horizon. The B2t horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. It typically is clay, but the range includes silty clay. The C horizon has hue of 2.5Y or 5Y, value of 3 to 7 (5 to 8 dry), and chroma of 2 to 4. It typically is clay loam, clay, and silty clay loam, but the lower part has strata of silty clay in some pedons.

Gardena series

The Gardena series consists of deep, moderately well drained, moderately permeable soils on glacial lake plains. These soils formed in medium textured glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Gardena soils are similar to Overly soils and are commonly adjacent to Borup, Glyndon, Perella, and Zell soils on the landscape. Overly soils contain more clay than the Gardena soils. The poorly drained Borup and somewhat poorly drained Glyndon soils have a calcic horizon within a depth of 16 inches. Perella soils are poorly drained. Zell soils have a mollic epipedon that is less than 16 inches thick and do not have a B horizon.

Typical pedon of Gardena silt loam, 0 to 3 percent slopes, 625 feet west and 25 feet north of the southeast corner of sec. 23, T. 154 N., R. 54 W.

Ap—0 to 5 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular and subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; abrupt smooth boundary.

A12—5 to 14 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak moderate prismatic structure parting to weak moderate subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; clear wavy boundary.

B2—14 to 21 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to weak medium subangular blocky; hard, firm, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; clear wavy boundary.

B3—21 to 26 inches; dark brown (10YR 3/3) silt loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to weak fine and medium subangular blocky; hard, firm, slightly sticky and slightly plastic; common very fine roots; few fine lime accumulations along root channels; slight effervescence; moderately alkaline; gradual wavy boundary.

C1ca—26 to 34 inches; pale brown (10YR 6/3) silt loam, light gray (2.5Y 7/2) dry; weak fine and medium subangular blocky structure parting to weak fine granular; hard, friable, sticky and plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2—34 to 40 inches; brown (10YR 5/3) silt loam, pale yellow (2.5Y 7/4) dry; weak fine and medium subangular and angular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—40 to 56 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine and medium subangular and angular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C4—56 to 60 inches; yellowish brown (10YR 5/4) very fine sandy loam, light yellowish brown (10YR 6/4) dry; common fine prominent dark red (2.5YR 3/6) and few fine distinct dark yellowish brown (10YR

4/6) and gray (10YR 6/1) mottles; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 36 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It typically is silt loam, but the range includes loam and very fine sandy loam. Some pedons have strata of silt, very fine sand, clay, or fine sandy loam in the lower part of the C horizon.

Gilby series

The Gilby series consists of deep, somewhat poorly drained, moderately slowly permeable soils in areas between beach ridges. These soils formed in glaciolacustrine deposits overlying till. They are medium textured and moderately fine textured. Slope is 0 to 1 percent.

Gilby soils are similar to Antler and Hamerly soils and are commonly adjacent to Antler, Grimstad, Svea, and Tonka soils on the landscape. Antler and Hamerly soils average more than 18 percent clay in the upper part of the control section. Also, Hamerly soils formed entirely in till. Grimstad soils contain less clay in the upper part than the Gilby soils. Svea and Tonka soils do not have a calcic horizon within a depth of 16 inches. Svea soils are moderately well drained. Tonka soils are poorly drained. They have an albic horizon.

Typical pedon of Gilby loam, 2,580 feet north and 150 feet west of the southeast corner of sec. 34, T. 154 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

A12—7 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few fine segregated masses of lime; slight effervescence; moderately alkaline; clear wavy boundary.

C1ca—12 to 26 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 6/1) dry; common fine distinct dark yellowish brown (10YR 3/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common fine threads of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C2—26 to 32 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; common medium distinct light gray (N 6/0), dark brown (10YR 4/3), and light brownish gray (2.5Y 6/2) mottles; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent pebbles; strong effervescence; moderately alkaline; abrupt wavy boundary.

IIC3—32 to 52 inches; gray (5Y 5/1) clay loam, light gray (5Y 7/1) dry; common medium distinct dark yellowish brown (10YR 4/4) and light olive brown (2.5Y 5/4) and few fine distinct red (2.5YR 4/6) mottles; massive; very hard, friable, slightly sticky and slightly plastic; thin cobble line in the upper part; about 10 percent pebbles; few fine dark iron concretions; strong effervescence; moderately alkaline; clear smooth boundary.

IIC4—52 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct dark yellowish brown (10YR 3/6), dark red (2.5YR 3/6), and gray (5YR 5/1) mottles; massive; hard, friable, sticky and plastic; about 10 percent pebbles; common fine and medium masses of gypsum crystals; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The depth to till ranges from 20 to 40 inches. The upper part of the control section averages less than 18 percent clay.

The A horizon has hue of 10YR, value of 2 (3 or 4 dry), and chroma of 1. The Cca horizon has hue of 10YR to 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 1 to 3. It typically is silt loam, but the range includes loam and very fine sandy loam. The C2 horizon has hue of 10YR or 2.5Y, value of 5 or 6 (6 or 7 dry), and chroma of 1 to 4. It does not occur in some pedons. The IIC horizon typically is clay loam, but the range includes loam.

Glyndon series

The Glyndon series consists of deep, somewhat poorly drained, moderately permeable soils on glacial lake plains. These soils formed in medium textured glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Glyndon soils are similar to Bearden soils and are commonly adjacent to Borup, Gardena, Perella, and Tiffany soils on the landscape. Bearden soils contain more clay than the Glyndon soils. Borup soils are poorly drained. Gardena, Perella, and Tiffany soils do not have a calcic horizon within a depth of 16 inches. Also, Perella and Tiffany soils are poorly drained.

Typical pedon of Glyndon silt loam, in an area of Glyndon-Tiffany silt loams, 1,650 feet south and 250 feet west of the northeast corner of sec. 35, T. 154 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky and weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

A12—8 to 13 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; abrupt wavy boundary.

C1ca—13 to 20 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) and few fine prominent light reddish brown (2.5YR 6/4) mottles; weak fine and medium subangular and angular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; abrupt smooth boundary.

C2ca—20 to 25 inches; light olive brown (2.5Y 5/4) silt loam, light gray (2.5Y 7/2) dry; few fine distinct brown (7.5YR 4/4) mottles; weak fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; disseminated lime throughout; violent effervescence; strongly alkaline; clear wavy boundary.

C3—25 to 40 inches; olive brown (2.5Y 4/4) silt loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark reddish brown (5YR 3/3) and grayish brown (2.5Y 5/2) mottles; massive; soft, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; clear irregular boundary.

C4—40 to 60 inches; olive brown (2.5Y 4/4) stratified very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct dark reddish brown (5YR 3/3) and dark brown (7.5YR 4/4) and few fine distinct very dark gray (5Y 3/1) and gray (5Y 5/1) mottles; massive; soft, very friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. The Cca horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. The part of the C horizon below the Cca horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It typically is very fine sandy loam and silt loam, but the range includes very fine sand, loamy very fine sand, and loam.

Grimstad series

The Grimstad series consists of deep, somewhat poorly drained soils in areas between beach ridges. These soils formed in moderately coarse textured and coarse textured glaciolacustrine deposits overlying medium textured and moderately fine textured till and glaciolacustrine deposits. Permeability is rapid in the upper part of the profile and moderate in the lower part. Slope is 0 to 1 percent.

Grimstad soils are commonly adjacent to Arveson, Gilby, Rockwell, and Towner soils on the landscape. Arveson soils do not have a IIC horizon of till or glaciolacustrine deposits within a depth of 40 inches. They are poorly drained. Gilby soils contain more clay in the upper part of the control section than the Grimstad soils. Rockwell soils are poorly drained. Towner soils do not have a calcic horizon within a depth of 16 inches. They are moderately well drained.

Typical pedon of Grimstad fine sandy loam, 395 feet south and 60 feet east of the northwest corner of sec. 26, T. 153 N., R. 54 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky and weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—10 to 21 inches; dark gray (10YR 4/1) fine sandy loam, gray (10YR 6/1) dry; common fine and medium distinct brown (10YR 4/3) mottles; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent pebbles; disseminated lime throughout; violent effervescence; moderately alkaline; clear irregular boundary.

C2—21 to 31 inches; brown (10YR 5/3) loamy fine sand, very pale brown (10YR 7/3) dry; weak medium and fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; clear wavy boundary.

C3—31 to 37 inches; brown (10YR 5/3) loamy fine sand, pale brown (10YR 6/3) dry; massive; soft, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

IIC4—37 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; many medium and large prominent dark yellowish brown (10YR 3/4), few medium prominent dark reddish brown (2.5YR 3/4), and few fine distinct light gray (2.5Y 7/2) mottles; massive; hard, friable, sticky and plastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to the IIC horizon ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. The Cca horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma

of 1 to 3. It typically is fine sandy loam, but the range includes loamy sand, loamy fine sand, and sandy loam. The part of the C horizon below the Cca horizon has hue of 10YR or 2.5Y, value of 5 or 6 (5 to 7 dry), and chroma of 2 to 4. It typically is loamy fine sand, but the range includes sand, fine sand, and loamy sand. The IIC horizon typically is clay loam, but the range includes loam, silt loam, and silty clay loam.

Hamar series

The Hamar series consists of deep, poorly drained, rapidly permeable soils on delta plains and beaches. These soils formed in coarse textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Hamar soils are similar to Tiffany soils and are commonly adjacent to Arveson, Hecla, Tiffany, and Wyndmere soils on the landscape. Tiffany soils contain more clay and less sand than the Hamar soils. Arveson and Wyndmere soils have a calcic horizon within a depth of 16 inches and contain more clay than the Hamar soils. Hecla soils are moderately well drained.

Typical pedon of Hamar sandy loam, 2,140 feet north and 370 feet west of the southeast corner of sec. 11, T. 153 N., R. 55 W.

Ap—0 to 6 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; abrupt smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; few fine distinct dark brown (10YR 3/3) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; mildly alkaline; abrupt smooth boundary.

AC—11 to 17 inches; very dark gray (10YR 3/1) loamy sand, dark grayish brown (10YR 4/2) dry; common fine distinct dark brown (10YR 3/3) mottles; weak medium and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; mildly alkaline; clear wavy boundary.

C1—17 to 26 inches; dark gray (10YR 4/1) loamy sand, grayish brown (10YR 5/2) dry; common fine and medium distinct dark brown (10YR 3/3) and common fine distinct dark reddish brown (5YR 3/2) mottles; massive; loose, nonsticky and nonplastic; moderately alkaline; clear wavy boundary.

C2—26 to 38 inches; grayish brown (2.5Y 5/2) loamy sand, light gray (2.5Y 7/2) dry; many medium distinct dark reddish brown (5YR 3/2) and common fine distinct brownish yellow (10YR 6/6) mottles; massive; loose, nonsticky and nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

C3—38 to 60 inches; grayish brown (2.5Y 5/2) loamy sand, light gray (2.5Y 7/2) dry; common medium distinct brown (10YR 4/3) and few fine distinct dark reddish brown (5YR 3/3) mottles; massive; loose, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The depth to carbonates ranges from 22 to 60 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It typically is sandy loam. In some pedons, however, the lower part is loamy fine sand. It has distinct or prominent mottles. The C horizon has hue of 10YR to 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. It typically is loamy sand, but the range includes loamy fine sand and fine sand.

Hamerly series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable soils on till plains. These soils formed in medium textured and moderately fine textured till. Slope ranges from 1 to 3 percent.

Hamerly soils are similar to Antler and Gilby soils and are commonly adjacent to Cresbard, Parnell, Svea, Tonka, and Vallers soils on the landscape. Antler and Gilby soils formed in glaciolacustrine deposits overlying till. Cresbard soils have a natric horizon. Parnell, Svea, and Tonka soils do not have a calcic horizon within a depth of 16 inches. Parnell and Tonka soils have an argillic horizon. Also, Parnell soils are very poorly drained and Tonka soils poorly drained. Svea soils are moderately well drained. Vallers soils are poorly drained.

Typical pedon of Hamerly loam, 1 to 3 percent slopes, 925 feet south and 130 feet west of the northeast corner of sec. 6, T. 154 N., R. 56 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular and subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—8 to 18 inches; light brownish gray (2.5Y 6/2) loam, white (2.5Y 8/2) dry; weak fine granular and weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent pebbles; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—18 to 60 inches; olive (5Y 5/3) loam, pale olive (5Y 6/3) dry; few fine prominent dark red (2.5YR 3/6) mottles; weak medium prismatic structure parting to weak fine angular and subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots to 36 inches; about 3 percent pebbles; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 16 inches in thickness and includes the upper part of the calcic horizon in some pedons. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 3. The part of the C horizon below the Cca horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 4. It typically is loam, but the range includes clay loam.

Hecla series

The Hecla series consists of deep, moderately well drained, rapidly permeable soils on delta plains and beaches. These soils formed in coarse textured glaciofluvial and glaciolacustrine deposits. Slope ranges from 1 to 6 percent.

The Hecla soils in this survey area are a taxadjunct to the Hecla series because they do not have low chroma mottles within 40 inches of the surface. This difference, however, does not alter the use or behavior of the soils.

Hecla soils are commonly adjacent to Embden, Hamar, Maddock, and Sioux soils on the landscape. Embden soils contain more clay throughout than the Hecla soils. Hamar soils are poorly drained. Maddock soils are well drained. Sioux soils have a higher content of coarse sand and gravel than the Hecla soils.

Typical pedon of Hecla fine sandy loam, in an area of Hecla-Maddock fine sandy loams, 1 to 6 percent slopes, 125 feet south and 50 feet west of the northeast corner of sec. 28, T. 151 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

AC—8 to 17 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; mildly alkaline; gradual wavy boundary.

C1—17 to 37 inches; yellowish brown (10YR 5/4) fine sand, pale brown (10YR 6/3) dry; few fine distinct strong brown (7.5YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; mildly alkaline; gradual smooth boundary.

C2—37 to 58 inches; dark brown (10YR 4/3) loamy sand, light brownish gray (2.5Y 6/2) dry; single grain; soft, very friable, nonsticky and nonplastic; about 5 percent pebbles; moderately alkaline; abrupt smooth boundary.

C3—58 to 60 inches; dark grayish brown (2.5Y 4/2) fine sand, light gray (2.5Y 7/2) dry; single grain; loose, nonsticky and nonplastic; about 35 percent shale in the sand fraction; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It has distinct or prominent mottles.

Inkster series

The Inkster series consists of deep, moderately well drained soils on delta plains and beaches. These soils formed in moderately coarse textured glaciofluvial and glaciolacustrine deposits. The sand fraction is dominantly highly weathered shale fragments. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 3 percent.

Inkster soils are similar to Embden soils and are commonly adjacent to Arvilla, Sioux, Tiffany, Walsh, and Wyndmere soils on the landscape. Embden soils have a sand fraction that is dominantly siliceous material. Arvilla soils are shallow or moderately deep over sand and gravel. Sioux soils are shallow or very shallow over sand and gravel. They are excessively drained. Tiffany soils are poorly drained. Walsh soils contain more clay than the Inkster soils. Wyndmere soils have a calcic horizon within a depth of 16 inches. They are somewhat poorly drained.

Typical pedon of Inkster sandy loam, 0 to 3 percent slopes, 2,540 feet east and 180 feet north of the southwest corner of sec. 15, T. 152 N., R. 55 W.

Ap—0 to 6 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; hard, very friable, slightly sticky and slightly plastic; few very fine roots; medium acid; abrupt smooth boundary.

B2—6 to 18 inches; very dark gray (10YR 3/1) sandy loam, gray (10YR 5/1) dry; weak fine and medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; slightly acid; clear wavy boundary.

B3—18 to 24 inches; very dark gray (10YR 3/1) sandy loam, grayish brown (2.5Y 5/2) dry; common fine distinct olive brown (2.5Y 4/4) and very dark grayish brown (2.5Y 3/2) mottles; weak fine and medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; slightly acid; gradual wavy boundary.

C1—24 to 37 inches; dark grayish brown (2.5Y 4/2) sandy loam, grayish brown (2.5Y 5/2) dry; common fine distinct olive brown (2.5Y 4/4) mottles; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; slightly acid; gradual wavy boundary.

C2—37 to 60 inches; dark olive gray (5Y 3/2) loamy sand, light olive gray (5Y 6/2) dry; many fine

prominent yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 34 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR to 5Y, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It typically is sandy loam, but the range includes fine sandy loam. The C horizon typically is sandy loam and loamy sand, but in some places it has strata of sand in the lower part.

Kloten series

The Kloten series consists of very shallow or shallow, well drained, moderately permeable soils on till plains. These soils formed in medium textured and moderately fine textured till overlying shale. Slope ranges from 9 to 25 percent.

Kloten soils are commonly adjacent to Barnes, Buse, Cavour, Edgeley, Miranda Variant, and Svea soils on the landscape. Barnes, Buse, Cavour, and Svea soils do not have a lithic contact. Barnes, Edgeley, and Svea soils have a B horizon. Cavour and Miranda Variant soils have a natric horizon. Edgeley and Miranda Variant soils do not have a IIR horizon within a depth of 20 inches.

Typical pedon of Kloten loam, in an area of Edgeley-Kloten loams, 6 to 25 percent slopes, 2,300 feet north and 200 feet east of the southwest corner of sec. 10, T. 152 N., R. 56 W.

A1—0 to 5 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; about 2 percent shale fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C1—5 to 9 inches; very dark gray (5Y 3/1) loam, gray (5Y 5/1) dry; weak very fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine and medium roots; about 15 percent shale fragments; slight effervescence; mildly alkaline; clear wavy boundary.

IIR—9 to 60 inches; very dark gray (5Y 3/1) and dark gray (5Y 4/1) hard bedded shale; few very fine roots, in fractures to 22 inches; dark brown (7.5YR 4/4) stains on faces of shale.

The depth to shale ranges from 9 to 20 inches. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. The C horizon typically is loam, but the range includes clay loam. The content of shale fragments increases with increasing depth. It ranges from 10 to 50 percent in the C horizon.

LaDelle series

The LaDelle series consists of deep, moderately well drained, moderately permeable soils on flood plains and stream terraces. These soils formed in medium textured and moderately fine textured alluvium. Slope ranges from 0 to 6 percent.

LaDelle soils are similar to Overly soils and are commonly adjacent to Lamoure, Rauville, and Zell soils on the landscape. Overly soils decrease regularly in content of organic matter with increasing depth. Lamoure soils are poorly drained, and Rauville soils are very poorly drained. Zell soils have a mollic epipedon that is less than 16 inches thick.

Typical pedon of LaDelle silt loam, 0 to 3 percent slopes, 1,980 feet west and 400 feet south of the northeast corner of sec. 2, T. 150 N., R. 50 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak and moderate medium angular blocky structure; hard, friable, sticky and plastic; common very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

A12—9 to 34 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium angular blocky structure; hard, friable, sticky and plastic; common very fine roots; mildly alkaline; abrupt wavy boundary.

C1—34 to 43 inches; dark grayish brown (2.5Y 4/2) and dark gray (10YR 4/1) silty clay loam, light brownish gray (2.5Y 6/2) and gray (10YR 5/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine angular blocky structure; hard, friable, sticky and plastic; few very fine roots; cracks filled with A material extend to 40 inches; few fine threads of lime; slight effervescence; mildly alkaline; abrupt wavy boundary.

A1b—43 to 60 inches; black (N 2/0) silty clay loam, dark gray (N 4/0) dry; weak very fine angular and subangular blocky structure; very hard, friable, sticky and plastic; few very fine roots; few fine threads of lime; mildly alkaline.

The thickness of the mollic epipedon ranges from 30 to 48 inches. The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. Some pedons have a B horizon. The C horizon typically is silty clay loam, but the range includes silt loam.

Lallie series

The Lallie series consists of deep, very poorly drained, slowly permeable, saline soils on glacial lake plains. These soils formed in moderately fine textured and fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Lallie soils are commonly adjacent to the saline Bearden soils and to the LaDelle, Ojata, and Zell soils

on the landscape. All of the adjacent soils have a mollic epipedon. The somewhat poorly drained Bearden and poorly drained Ojata soils are in the slightly higher lying areas. They have a calcic horizon within a depth of 16 inches. The moderately well drained LaDelle and well drained Zell soils are on the higher lying, steeper slopes that border many of the sloughs.

Typical pedon of Lallie silty clay loam, ponded, 1,935 feet east and 110 feet south of the northwest corner of sec. 33, T. 152 N., R. 52 W.

O1—3 inches to 0; black (5Y 2.5/1) partly decomposed organic material, dark gray (5Y 4/1) dry; slight effervescence; abrupt smooth boundary.

A1—0 to 4 inches; dark olive gray (5Y 3/2) silty clay loam, olive gray (5Y 5/2) dry; weak medium and fine subangular blocky structure; slightly hard, very friable, sticky and slightly plastic; many very fine and common fine roots; common fine salt crystals; strong effervescence; mildly alkaline; abrupt irregular boundary.

C1g—4 to 20 inches; dark olive gray (5Y 3/2) stratified silty clay loam, light olive gray (5Y 6/2) dry; common medium distinct olive (5Y 4/4) and common fine distinct dark brown (7.5YR 4/4) mottles; moderate medium prismatic structure parting to weak medium and fine angular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; few fine salt crystals; strong effervescence; mildly alkaline; clear wavy boundary.

C2g—20 to 28 inches; olive gray (5Y 4/2) stratified silty clay, light olive gray (5Y 6/2) dry; common medium distinct dark reddish brown (5YR 3/3) and dark brown (7.5YR 4/4) and common fine distinct very pale brown (10YR 8/3) mottles; massive; very hard, firm, very sticky and very plastic; few very fine roots; common medium segregated masses of lime; strong effervescence; mildly alkaline; clear wavy boundary.

C3g—28 to 60 inches; dark gray (5Y 4/1) silty clay, light olive gray (5Y 6/2) dry; common medium distinct very dark grayish brown (2.5Y 3/2) mottles; massive; very hard, firm, very sticky and very plastic; common medium segregated masses of lime; slight effervescence; mildly alkaline.

These soils decrease irregularly in content of organic matter with increasing depth. The electric conductivity ranges from 4 to 16 millimhos per cubic centimeter.

The O horizon is as much as 4 inches thick. Some pedons do not have an O horizon. The A horizon has hue of 2.5Y or 5Y, value of 3 or 4 (4 to 6 dry), and chroma of 1 or 2. The C horizon has hue of 5Y or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. Some pedons have a buried A horizon.

Lamoure series

The Lamoure series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in medium textured and moderately fine textured alluvium. Slope is 0 to 1 percent.

Lamoure soils are similar to Rauville soils and are commonly adjacent to LaDelle, Rauville, and Velva soils on the landscape. Rauville soils are very poorly drained. LaDelle soils are moderately well drained. Velva soils are well drained. They contain less clay and more sand than the Lamoure soils.

Typical pedon of Lamoure silty clay loam, 2,400 feet west and 1,340 feet north of the southeast corner of sec. 28, T. 154 N., R. 56 W.

A11—0 to 15 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine and weak medium granular structure; slightly hard, friable, sticky and plastic; common very fine and fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

A12g—15 to 41 inches; black (5Y 2/1) silt loam, gray (5Y 5/1) dry; moderate fine and medium prismatic structure parting to weak and moderate fine angular and subangular blocky; slightly hard, friable, sticky and plastic; common very fine roots; cracks filled with A11 material extending to 28 inches; about 6 percent pebbles in the lower 6 inches; slight effervescence; mildly alkaline; clear wavy boundary.

C1g—41 to 53 inches; very dark gray (5Y 3/1) silt loam, gray (5Y 5/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak fine angular and subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; slight effervescence; moderately alkaline; clear wavy boundary.

C2g—53 to 60 inches; dark gray (5Y 4/1) silt loam, light gray (5Y 7/1) dry; few fine distinct dark brown (7.5YR 4/4) and few fine prominent olive yellow (2.5Y 6/8) mottles; massive; hard, friable, sticky and plastic; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 24 to 41 inches. The A horizon has hue of 10YR, neutral, or 5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. The C horizon typically is silt loam, but in some pedons it is silty clay loam and in some it has strata of sand and gravel in the lower part. It has few to many, distinct or prominent mottles. Some pedons have a buried A horizon.

Maddock series

The Maddock series consists of deep, well drained, rapidly permeable soils on delta plains and beaches. These soils formed in coarse textured glaciofluvial and glaciolacustrine deposits. Slope ranges from 3 to 25 percent.

Maddock soils are commonly adjacent to Embden, Hamar, and Hecla soils on the landscape. Embden soils contain more clay throughout than the Maddock soils.

Hamar soils are poorly drained. Hecla soils are moderately well drained.

Typical pedon of Maddock fine sandy loam, in an area of Hecla-Maddock fine sandy loams, 1 to 6 percent slopes, 1,600 feet west and 640 feet north of the southeast corner of sec. 3, T. 153 N., R. 55 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular and subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

AC—9 to 14 inches; very dark grayish brown (10YR 3/2) loamy sand, brown (10YR 5/3) dry; weak medium and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; neutral; clear wavy boundary.

C1—14 to 24 inches; dark brown (10YR 3/3) fine sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

C2—24 to 37 inches; brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; neutral; clear wavy boundary.

C3—37 to 60 inches; grayish brown (10YR 5/2) fine sand, light gray (10YR 7/2) dry; common medium distinct dark reddish brown (5YR 3/3) and few medium distinct dark yellowish brown (10YR 3/4) mottles; single grain; loose, nonsticky and nonplastic; about 5 percent pebbles; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. It is fine sandy loam or sandy loam. The C horizon typically is fine sand, but the range includes loamy fine sand.

Manfred series

The Manfred series consists of deep, very poorly drained, slowly permeable, alkali soils on till plains. These soils formed in medium textured and moderately fine textured till and alluvium. Slope is 0 to 1 percent.

The Manfred soils in this survey area contain more clay in the subsoil than is defined as the range for the Manfred series. This difference, however, does not alter the use or behavior of the soils.

Manfred soils are commonly adjacent to Hamerly, Parnell, and Vallers soils on the landscape. The adjacent soils do not have a natric horizon. Hamerly soils are somewhat poorly drained and Vallers soils poorly drained. Parnell soils contain more clay in the B horizon than the Manfred soils.

Typical pedon of Manfred clay loam, in an area of Vallers-Manfred clay loams, saline, 1,980 feet south and 1,320 feet west of the northeast corner of sec. 22, T. 149 N., R. 56 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; about 2 percent pebbles; slight effervescence; moderately alkaline; abrupt smooth boundary.

B2t—8 to 14 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; few very fine roots; clay films on faces of peds; common fine threads and masses of lime; slight effervescence; moderately alkaline; clear irregular boundary.

C1ca—14 to 26 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common fine and medium distinct light gray (2.5Y 7/2) mottles; weak medium and coarse prismatic structure parting to moderate fine angular blocky; hard, friable, sticky and plastic; few very fine roots; about 2 percent pebbles; disseminated lime throughout; strong effervescence; strongly alkaline; clear wavy boundary.

C2—26 to 35 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; weak fine angular blocky structure; very hard, friable, sticky and plastic; few very fine roots; common fine masses of gypsum crystals; slight effervescence; moderately alkaline; clear wavy boundary.

C3g—35 to 60 inches; gray (5Y 5/1) loam, light gray (5Y 7/2) dry; common fine and medium prominent dark brown (10YR 3/3), few fine prominent dark red (2.5YR 3/6), and few fine distinct strong brown (7.5YR 5/8) mottles; massive; very hard, firm, sticky and plastic; slight effervescence; strongly alkaline.

The thickness of the solum ranges from 8 to 20 inches. The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 to 5 dry), chroma of 1 or less. The B horizon has hue of 2.5Y, 5Y, or neutral, value of 2 or 3 (3 to 5 dry), and chroma of 2 or less. It typically is clay loam, but the range includes silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It typically is clay loam and loam, but the range includes silty clay loam.

Marysland series

The Marysland series consists of deep, poorly drained soils that are moderately permeable in the upper part and are rapidly permeable in the lower part of the substratum. These soils are on beaches and delta plains. They are moderately deep over sand and gravel. They formed in medium textured and moderately fine textured deposits overlying coarse textured glaciofluvial and glaciolacustrine deposits. Slope is 0 to 1 percent.

Marysland soils are similar to Divide soils and are commonly adjacent to Arveson, Divide, Renshaw, and

Walsh soils on the landscape. Divide soils are somewhat poorly drained. Arveson soils contain less clay in the upper part than the Marysland soils. The somewhat excessively drained Renshaw and moderately well drained Walsh soils do not have a calcic horizon within a depth of 16 inches. Also, Walsh soils do not have a IIC horizon within a depth of 40 inches.

Typical pedon of Marysland loam, 320 feet north and 1,240 feet east of the southwest corner of sec. 11, T. 153 N., R. 55 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

A12ca—6 to 16 inches; black (10YR 2/1) loam, very dark gray (N 3/0) dry; few fine distinct dark brown (7.5YR 3/2) mottles; moderate medium prismatic structure parting to moderate medium and fine angular blocky; soft, friable, slightly sticky and slightly plastic; common fine and very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1ca—16 to 33 inches; dark grayish brown (2.5Y 4/2) sandy clay loam, gray (5Y 6/1) dry; few fine distinct dark brown (7.5YR 3/2) mottles; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

IIC2—33 to 43 inches; olive brown (2.5Y 4/4) gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 30 percent pebbles; slight effervescence; moderately alkaline; gradual wavy boundary.

IIC3—43 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly coarse sand, very pale brown (10YR 7/3) dry; few fine distinct brownish yellow (10YR 6/6) mottles; single grain; loose, nonsticky and nonplastic; about 45 percent pebbles; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to gravelly coarse sand ranges from 20 to 40 inches.

The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. The Cca horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. It has few to many, distinct or prominent mottles. It typically is sandy clay loam, but the range includes clay loam and loam. The IIC horizon typically is gravelly coarse sand and very gravelly coarse sand, but the range includes sand and fine sand.

Miranda series

The Miranda series consists of deep, somewhat poorly drained, very slowly permeable, alkali soils on till plains. These soils formed in medium textured and moderately fine textured till. Slope ranges from 0 to 3 percent.

The Miranda soils in this survey area contain more clay than is defined as the range for the Miranda series. This difference, however, does not alter the use or behavior of the soils.

Miranda soils are similar to Exline soils and are commonly adjacent to Barnes, Cavour, Hamerly, Parnell, and Svea soils on the landscape. Exline soils formed in glaciolacustrine deposits. Barnes, Hamerly, Parnell, and Svea soils do not have a natric horizon. Cavour soils have an A horizon that is thicker than that of the Miranda soils. They do not have visible salts within a depth of 16 inches.

Typical pedon of Miranda loam, in an area of Cavour-Miranda loams, 0 to 3 percent slopes, 900 feet west and 120 feet north of the southeast corner of sec. 33, T. 152 N., R. 56 W.

A2—0 to 3 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak very thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; slightly acid; abrupt smooth boundary.

B2t—3 to 12 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; strong coarse columnar structure parting to moderate fine and medium angular blocky; extremely hard, extremely firm, sticky and plastic; few very fine roots; many thin and few moderately thick black (10YR 2/1) clay films on faces of peds; thin light brownish gray (10YR 6/2) coatings on the tops of columns; mildly alkaline; clear wavy boundary.

B3cssa—12 to 16 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate fine and medium angular blocky structure; hard, friable, sticky and plastic; few very fine roots; black (10YR 2/1) coatings on faces of peds; common fine and medium salt crystals; common fine and medium segregated masses of gypsum crystals; moderately alkaline; clear wavy boundary.

C1cacs—16 to 23 inches; brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; about 5 percent pebbles; common fine segregated masses of lime and of gypsum crystals; strong effervescence; moderately alkaline; clear wavy boundary.

C2cacs—23 to 60 inches; brown (10YR 5/3) clay loam, very pale brown (10YR 7/3) dry; weak fine and medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; about 5 percent pebbles; common fine segregated masses

of gypsum crystals; disseminated lime throughout; violent effervescence; strongly alkaline.

The thickness of the solum ranges from 10 to 22 inches. The depth to a horizon in which gypsum and salts have accumulated ranges from 6 to 16 inches. The content of clay in the control section averages as low as 35 percent in some pedons and as high as 45 percent in others.

Some pedons have an Ap horizon. The B2t horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It typically is clay loam, but the range includes clay. The B3cssa horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 2 or 3. The C horizon has few to many segregated masses of gypsum, lime, and other more soluble salts.

Miranda Variant

The Miranda Variant consists of moderately deep, moderately well drained, very slowly permeable, alkali soils on till plains. These soils formed in moderately fine textured till overlying shale. Slope ranges from 1 to 15 percent.

Miranda Variant soils are commonly adjacent to Barnes, Cavour, Edgeley, Kloten, and Svea soils on the landscape. Barnes, Edgeley, Kloten, and Svea soils do not have a natric horizon. Cavour soils have neither shale in the lower part of the profile nor visible salts within a depth of 16 inches. They are on the lower slopes.

Typical pedon of Miranda Variant loam, 1 to 15 percent slopes, 2,445 feet north and 180 feet east of the southwest corner of sec. 14, T. 152 N., R. 56 W.

A2—0 to 4 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate very thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; medium acid; abrupt smooth boundary.

B2t—4 to 15 inches; black (N 2/0) clay, very dark gray (N 3/0) dry; strong coarse and very coarse columnar structure parting to strong medium and coarse angular blocky; extremely hard, very firm, very sticky and very plastic; many moderately thick clay films on faces of peds; light brownish gray (10YR 6/2) coatings on the tops of columns; common very fine roots; slightly acid; clear wavy boundary.

B3sa—15 to 25 inches; dark olive gray (5Y 3/2) clay, olive gray (5Y 5/2) dry; many fine and medium distinct light brownish gray (10YR 6/2) mottles; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; hard, firm, sticky and plastic; few fine salt crystals; few fine segregated masses of gypsum crystals; common very fine roots; moderately alkaline; abrupt wavy boundary.

IICr—25 to 60 inches; gray (5Y 5/1) and dark gray (5Y 4/1) weathered shale; strong brown (7.5YR 5/6) stains on faces of shale fragments.

The solum ranges from 10 to 28 inches in thickness. In some pedons it has carbonates. The depth to a horizon in which salts have accumulated ranges from 10 to 15 inches. The depth to shale ranges from 20 to 40 inches. The control section averages as low as 40 percent clay in some pedons and as high as 60 percent clay in others.

Some pedons have an A1 horizon. The B2t horizon has hue of 10YR, 2.5Y, or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 2 or less. Some pedons have a C horizon.

Nutley series

The Nutley series consists of deep, well drained, slowly permeable soils on glacial lake plains. These soils formed in fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Nutley soils are similar to Wahpeton soils and are commonly adjacent to Aberdeen, Exline, and Wahpeton soils on the landscape. Wahpeton soils have a mollic epipedon that is more than 24 inches thick. They are moderately well drained. Aberdeen and Exline soils have a natric horizon.

Typical pedon of Nutley silty clay, 425 feet west and 75 feet north of the southeast corner of sec. 19, T. 153 N., R. 55 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular and subangular blocky structure; very hard, firm, very plastic and very sticky; common very fine roots; mildly alkaline; abrupt irregular boundary.

B21—8 to 19 inches; very dark grayish brown (2.5Y 3/2) silty clay, light brownish gray (2.5Y 6/2) dry; moderate fine angular and subangular blocky structure; very hard, firm, very sticky and very plastic; common very fine roots; mildly alkaline; gradual irregular boundary.

B22—19 to 23 inches; dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) clay, light brownish gray (2.5Y 6/2) dry; few fine distinct dark reddish brown (5YR 3/3) mottles; moderate medium prismatic structure parting to moderate fine and very fine subangular blocky; very hard, firm, very sticky and very plastic; common very fine roots; mildly alkaline; clear irregular boundary.

C1—23 to 46 inches; dark grayish brown (2.5Y 4/2) silty clay, light gray (2.5Y 7/2) dry; common fine distinct dark reddish brown (5YR 3/3) mottles; massive; hard, friable, sticky and plastic; few very fine roots; few fine segregated masses of lime; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—46 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light gray (2.5Y 7/2) dry; many fine distinct dark reddish brown (5YR 3/3) and common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; very hard, firm, very sticky and plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 6 to 16 inches. When the soil is dry, vertical cracks half an inch to 2 inches wide and several feet long extend through the solum.

The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. The B horizon has hue of 10YR to 5Y, value of 3 to 5 (4 to 6 dry), and chroma of 1 or 2.

Ojata series

The Ojata series consists of deep, poorly drained, moderately slowly permeable, very strongly saline soils on glacial lake plains and in areas between beach ridges. These soils formed in medium textured and moderately fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Ojata soils are similar to Borup and Colvin soils and are commonly adjacent to Bearden, Colvin, Lallie, and Perella soils on the landscape. The similar and adjacent soils have an electrical conductivity of less than 16 millimhos per cubic centimeter. Borup soils contain less clay than the Ojata soils. Bearden soils are somewhat poorly drained. Lallie soils are very poorly drained. They do not have a mollic epipedon. Perella soils do not have a calcic horizon within a depth of 16 inches.

Typical pedon of Ojata silty clay loam, 1,000 feet east and 200 feet north of the southwest corner of sec. 24, T. 152 N., R. 51 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, dark gray (N 4/0) dry; weak very fine subangular blocky structure; hard, friable, sticky and plastic; few fine salt crystals; common very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1casa—8 to 20 inches; gray (5Y 6/1) silt loam, light gray (5Y 7/1) dry; many fine and medium distinct dark gray (5Y 4/1) mottles; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; cracks filled with A material extend to 18 inches; few fine salt crystals; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2—20 to 32 inches; dark grayish brown (2.5Y 4/2) very finely stratified silt loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct gray (5Y 5/1) and yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; strongly alkaline; gradual wavy boundary.

C3—32 to 47 inches; dark grayish brown (2.5Y 4/2) very finely stratified silt loam, pale yellow (2.5Y 7/4) dry; common fine and medium distinct gray (2.5Y 6/1) and few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; slight effervescence; strongly alkaline; gradual wavy boundary.

C4—47 to 60 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silt loam, pale yellow (2.5Y 7/4) and light yellowish brown (2.5Y 6/4) dry; common fine and medium distinct gray (5Y 5/1) mottles; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common medium dark reddish brown (5YR 3/4) concretions of iron and manganese; common large masses of gypsum crystals; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon and the Ccasa horizon have few to many salt crystals.

The A horizon has hue of 10YR, 5Y, or neutral, value of 2 (3 or 4 dry), and chroma of 1 or less. The Ccasa horizon has hue of 2.5Y or 5Y, value of 3 to 6 (4 to 7 dry), and chroma of 1 or 2. The C horizon is silt loam, but the range includes silty clay loam. Also, the lower part has strata of very fine sand, clay loam, or clay in some pedons.

Overly series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on glacial lake plains. These soils formed in medium textured and moderately fine textured glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Overly soils are similar to Gardena and LaDelle soils and are commonly adjacent to Bearden, Colvin, Perella, and Svea soils on the landscape. Gardena soils contain less clay throughout than the Overly soils. LaDelle soils decrease irregularly in content of organic matter as depth increases. Bearden and Colvin soils have a calcic horizon within a depth of 16 inches. Bearden soils are somewhat poorly drained. Colvin and Perella soils are poorly drained. Svea soils contain more sand throughout than the Overly soils. They formed in glaciolacustrine deposits overlying till.

Typical pedon of Overly silty clay loam, 0 to 3 percent slopes, 250 feet north and 220 feet east of the southwest corner of sec. 31, T. 154 N., R. 55 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

A12—7 to 12 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak fine granular and subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; clear wavy boundary.

B2—12 to 23 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine and medium prismatic structure parting to moderate fine subangular blocky; hard, friable, sticky and plastic; few very fine roots; mildly alkaline; gradual wavy boundary.

C1ca—23 to 32 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; strong effervescence; mildly alkaline; clear wavy boundary.

C2ca—32 to 48 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct dark brown (10YR 3/3) mottles; weak very fine and fine subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common fine and medium segregated masses of lime; strong effervescence; mildly alkaline; abrupt smooth boundary.

C3—48 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common fine distinct dark brown (7.5YR 4/2) mottles; weak very fine and fine subangular blocky structure; hard, very friable, sticky and plastic; few very fine roots; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It typically is silty clay loam, but the range includes silt loam. The Cca horizon has hue of 2.5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 4. The part of the C horizon below the Cca horizon typically is silty clay loam, but the range includes silt loam. Some pedons have strata of sand or clay below a depth of 40 inches.

Parnell series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on till plains and in areas between beach ridges. These soils formed in medium textured and moderately fine textured colluvium overlying till. Slope is 0 to 1 percent.

Parnell soils are similar to Tonka soils and are commonly adjacent to Hamerly, Tonka, and Vallers soils on the landscape. The poorly drained Tonka soils have an albic horizon that is more than 4 inches thick. The somewhat poorly drained Hamerly and poorly drained Vallers soils have a calcic horizon within a depth of 16 inches and do not have an argillic horizon.

Typical pedon of Parnell silt loam, 910 feet south and 280 feet east of the northwest corner of sec. 29, T. 152 N., R. 56 W.

A1—0 to 10 inches; black (N 2/0) silt loam, dark gray (N 4/0) dry; weak very fine subangular blocky and weak fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine and few fine roots; neutral; abrupt smooth boundary.

B21tg—10 to 18 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; very hard, firm, sticky and plastic; few very fine roots; few to many thin clay films; mildly alkaline; abrupt wavy boundary.

B22tg—18 to 24 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; few to many thin clay films; mildly alkaline; abrupt wavy boundary.

B3g—24 to 44 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine and medium subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; mildly alkaline; clear wavy boundary.

Cg—44 to 60 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; few fine distinct reddish brown (5YR 4/4) mottles; weak very fine and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; about 8 percent pebbles; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. The thickness of the solum ranges from 35 to more than 60 inches.

The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. Some pedons have an A2 horizon, which is as much as 4 inches thick. The B2 horizon has hue of 10YR to 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. It typically is silty clay loam, but the range includes clay loam, silty clay, and clay. The C horizon typically is loam, but the range includes clay loam.

Perella series

The Perella series consists of deep, poorly drained, moderately slowly permeable soils on glacial lake plains. These soils formed in medium textured and moderately fine textured glaciolacustrine deposits. Slope is 0 to 1 percent.

Perella soils are commonly adjacent to Bearden, Borup, Colvin, and Glyndon soils on the landscape. The

adjacent soils have a calcic horizon within a depth of 16 inches. Also, Bearden and Glyndon soils are somewhat poorly drained.

Typical pedon of Perella silty clay loam, in an area of Bearden-Perella silty clay loams, 1,880 feet west and 205 feet south of the northeast corner of sec. 33, T. 149 N., R. 50 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate medium subangular blocky structure; very hard, firm, slightly sticky and plastic; common fine roots; mildly alkaline; abrupt smooth boundary.

A12—8 to 11 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate medium subangular blocky structure; very hard, firm, slightly sticky and plastic; common fine roots; mildly alkaline; clear irregular boundary.

B21g—11 to 14 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; few fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure parting to strong fine angular blocky; very hard, firm, slightly sticky and plastic; few fine roots; mildly alkaline; clear wavy boundary.

B22g—14 to 20 inches; black (N 2/0) silty clay loam, dark gray (5Y 4/1) dry; few fine prominent dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; extremely hard, firm, sticky and plastic; few fine roots; mildly alkaline; gradual wavy boundary.

B23g—20 to 24 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very hard, firm, slightly sticky and plastic; few fine roots; moderately alkaline; gradual wavy boundary.

C1g—24 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; very hard, firm, sticky and plastic; common fine segregated masses of gypsum crystals; few small irregular masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2g—32 to 60 inches; olive brown (2.5Y 4/4) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; very hard, firm, sticky and plastic; common fine segregated masses of gypsum crystals; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The depth to carbonates ranges from 18 to 30 inches.

The A horizon has hue of 10YR, 5Y, or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. It is silty clay loam or silty clay. The B horizon has hue of 2.5Y, 5Y, or neutral, value of 2 to 4 (3 to 5 dry), and chroma of 3 or less. It has few to many, distinct or prominent mottles. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It typically is silty clay loam, but the range includes silt loam. Also, the lower part has strata of silty clay in some pedons.

Rauville series

The Rauville series consists of deep, very poorly drained, moderately slowly permeable soils on bottom land and in seepy areas. These soils formed in medium textured and moderately fine textured alluvium. Slope is 0 to 1 percent.

Rauville soils are similar to Lamoure soils and are commonly adjacent to Arveson, Colvin, LaDelle, Lamoure, and Vallers soils on the landscape. Arveson, Colvin, Lamoure, and Vallers soils are poorly drained. Also, Arveson, Colvin, and Vallers soils have a calcic horizon within a depth of 16 inches. LaDelle soils are moderately well drained.

Typical pedon of Rauville silt loam, 2,400 feet north and 500 feet east of the southwest corner of sec. 34, T. 154 N., R. 55 W.

O1—2 inches to 0; black (10YR 2/1) partly decomposed organic material, very dark gray (10YR 3/1) dry; slight effervescence; abrupt smooth boundary.

A11—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

A12g—7 to 30 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

C1g—30 to 40 inches; dark gray (N 4/0) silty clay loam, light gray (N 6/0) dry; massive; hard, friable, sticky and plastic; strong effervescence; mildly alkaline; clear wavy boundary.

IIC2g—40 to 60 inches; light brownish gray (2.5Y 6/2) loamy sand, white (2.5Y 8/2) dry; common fine distinct olive gray (5Y 5/2) and brown (10YR 4/3) mottles; massive; soft, very friable, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 35 inches. Some pedons do not have an O horizon. The A horizon has hue of 10YR, 5Y, or neutral, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. The C horizon typically is silty clay loam, but the range includes silt loam. The IIC horizon typically is loamy sand, but the range includes stratified sand and gravel. Some pedons do not have a IIC horizon.

Renshaw series

The Renshaw series consists of deep, somewhat excessively drained soils that are moderately rapidly permeable in the upper part and very rapidly permeable in the lower part. These soils are on beaches, delta plains, and stream terraces. They are shallow over sand and gravel. They formed in medium textured and moderately coarse textured deposits overlying coarse textured glaciofluvial and glaciolacustrine deposits. Slope ranges from 1 to 6 percent.

Renshaw soils are similar to Arvilla soils and are commonly adjacent to Divide and Sioux soils on the landscape. Arvilla soils contain less clay in the solum than the Renshaw soils. Divide soils have a calcic horizon within a depth of 16 inches. They are somewhat poorly drained. Sioux soils do not have a B horizon.

Typical pedon of Renshaw loam, 1 to 3 percent slopes, 1,305 feet west and 90 feet south of the northeast corner of sec. 23, T. 153 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky and weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; few fine and common very fine roots; about 5 percent pebbles; mildly alkaline; clear irregular boundary.

B2—8 to 15 inches; very dark gray (10YR 3/1) sandy clay loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 10 percent pebbles; mildly alkaline; clear wavy boundary.

IIC1ca—15 to 22 inches; brown (10YR 4/3) gravelly loamy sand, pale brown (10YR 6/3) dry; single grain; soft, loose, nonsticky and nonplastic; few fine roots; about 35 percent pebbles; crusts of lime coat the undersides of pebbles; strong effervescence; moderately alkaline; clear irregular boundary.

IIC2—22 to 36 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 40 percent pebbles; crusts of lime coat the undersides of pebbles; slight effervescence; moderately alkaline; abrupt smooth boundary.

IIC3—36 to 57 inches; brown (10YR 4/3) very gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; about 55 percent pebbles; crusts of lime coat the undersides of pebbles; slight effervescence; moderately alkaline; abrupt smooth boundary.

IIC4—57 to 60 inches; dark brown (10YR 3/3) coarse sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 15 percent pebbles; crusts of lime coat the undersides of pebbles; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The thickness of the solum, or the depth to sand and gravel, ranges from 14 to 20 inches. The content of pebbles is less than 30 percent in the solum.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 1 to 4.

Rockwell series

The Rockwell series consists of deep, poorly drained, moderately permeable soils in areas between beach ridges. These soils formed in moderately coarse textured and coarse textured glaciolacustrine deposits overlying moderately fine textured and medium textured till and glaciolacustrine deposits. Slope is 0 to 1 percent.

Rockwell soils are similar to Arveson soils and are commonly adjacent to Arveson, Gilby, Grimstad, and Towner soils on the landscape. Arveson soils do not have a IIC horizon of till or glaciolacustrine deposits within a depth of 40 inches. Gilby and Grimstad soils are somewhat poorly drained. Also, Gilby soils contain more clay throughout than the Rockwell soils. Towner soils do not have a calcic horizon within a depth of 16 inches. They are moderately well drained.

Typical pedon of Rockwell fine sandy loam, 370 feet south and 375 feet east of the northwest corner of sec. 28, T. 149 N., R. 51 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; few fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

A12—6 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; slight effervescence; mildly alkaline; abrupt wavy boundary.

C1ca—9 to 16 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, gray (10YR 6/1) dry; few fine distinct dark yellowish brown (10YR 4/4) and olive (5Y 5/3) mottles; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—16 to 24 inches; dark grayish brown (2.5Y 4/2) fine sand, grayish brown (2.5Y 5/2) dry; few fine distinct strong brown (7.5YR 5/6) and common medium distinct olive gray (5Y 4/2) mottles; soft, very friable, nonsticky and nonplastic; thin cobble line in the lower part; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIC3—24 to 60 inches; gray (5Y 5/1) loam, light gray (5Y 7/1) dry; many coarse distinct strong brown (7.5YR 5/6) and few fine distinct black (10YR 2/1) mottles; massive; very hard, firm, sticky and plastic; common fine segregated masses of gypsum crystals; few fine irregular masses of lime; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to the IIC horizon ranges from 20 to 40 inches.

The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), chroma of 1 or less. The Cca horizon has hue of 10YR to 5Y or neutral, value of 4 to 6 (5 to 8 dry), and chroma of 2 or less. The C2 horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. It typically is fine sand, but the range includes sand, loamy sand, and loamy fine sand. The IIC horizon typically is loam, but the range includes silt loam.

Sioux series

The Sioux series consists of deep, excessively drained, very rapidly permeable soils on delta plains, beaches, and till plains. These soils are shallow or very shallow over sand and gravel. They formed in medium textured to coarse textured glaciofluvial and glaciolacustrine deposits. Slope ranges from 1 to 15 percent.

Sioux soils are commonly adjacent to Arvilla, Barnes, and Renshaw soils on the landscape. The adjacent soils have a B horizon. Also, Barnes soils contain more clay throughout than the Sioux soils and formed in till.

Typical pedon of Sioux loam, 1 to 15 percent slopes, 1,900 feet west and 50 feet south of the northeast corner of sec. 8, T. 154 N., R. 55 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky and fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent pebbles; slight effervescence; moderately alkaline; abrupt wavy boundary.

AC—7 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; about 55 percent pebbles; moderately alkaline; clear wavy boundary.

C1—10 to 22 inches; dark grayish brown (2.5Y 4/2) gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 30 percent pebbles; crusts of lime coat the undersides of pebbles; slight effervescence; moderately alkaline; clear wavy boundary.

C2—22 to 41 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 60 percent pebbles; crusts of lime coat the undersides of pebbles; slight effervescence; moderately alkaline; abrupt smooth boundary.

C3—41 to 60 inches; dark brown (10YR 4/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 10 percent pebbles; common fine segregated masses of lime in the lower 4 inches; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon and the depth to sand and gravel range from 7 to 14 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The C horizon typically is stratified gravelly coarse sand, very gravelly coarse sand, and coarse sand, but in some pedons it has strata of sand and loamy coarse sand.

Svea series

The Svea series consists of deep, moderately well drained, moderately slowly permeable soils on till plains and in areas between beach ridges. These soils formed in medium textured and moderately fine textured till and glaciolacustrine deposits overlying till. Slope ranges from 0 to 9 percent.

Svea soils are similar to Walsh soils and are commonly adjacent to Antler, Barnes, Buse, Cavour, Cresbard, Gilby, and Hamerly soils on the landscape. Walsh soils do not have a Cca horizon. They are on delta plains. Antler, Gilby, and Hamerly soils have a calcic horizon within a depth of 16 inches. They are somewhat poorly drained. Barnes soils have a mollic epipedon that is less than 16 inches thick. Buse soils do not have a B horizon. Cavour and Cresbard soils have a natric horizon.

Typical pedon of Svea loam, in an area of Svea-Buse loams, 1 to 6 percent slopes, 1,600 feet south and 375 feet east of the northwest corner of sec. 17, T. 152 N., R. 56 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; abrupt smooth boundary.

A12—10 to 17 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; abrupt wavy boundary.

B2—17 to 31 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak fine and medium prismatic structure parting to weak fine and medium angular blocky; hard, friable, sticky

and plastic; few very fine roots; strong effervescence; mildly alkaline; clear wavy boundary.

C1ca—31 to 48 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; common fine distinct light gray (10YR 7/1) mottles; weak fine and medium prismatic structure parting to weak fine and medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; about 3 percent pebbles; common fine segregated masses and threads of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C2—48 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent light gray (10YR 7/1) mottles; weak very fine and fine angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; about 4 percent pebbles; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to more than 32 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 4. It typically is clay loam, but the range includes loam. The Cca horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. The C2 horizon typically is clay loam, but the range includes loam.

Tiffany series

The Tiffany series consists of deep, poorly drained, moderately permeable soils on delta plains, on glacial lake plains, and in areas between beach ridges. These soils formed in moderately coarse textured and medium textured glaciofluvial and glaciolacustrine deposits. Slope is 0 to 1 percent.

Tiffany soils are similar to Hamar soils and are commonly adjacent to Arveson, Embden, Glyndon, Hamar, and Wyndmere soils on the landscape. Hamar soils contain less clay and more sand throughout than the Tiffany soils. Arveson, Glyndon, and Wyndmere soils have a calcic horizon within a depth of 16 inches. Also, Glyndon soils contain less sand throughout than the Tiffany soils. Embden soils are moderately well drained.

Typical pedon of Tiffany fine sandy loam, in an area of Wyndmere-Tiffany fine sandy loams, 550 feet south and 330 feet east of the northwest corner of sec. 23, T. 151 N., R. 54 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and nonplastic; many very fine roots; slightly acid; abrupt smooth boundary.

A12—10 to 15 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; many fine distinct dark brown (10YR 4/3) mottles; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common very fine roots; neutral; clear wavy boundary.

AC—15 to 23 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; many medium prominent dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; few fine black concretions of iron and manganese; neutral; clear wavy boundary.

C1—23 to 36 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/3) dry; many medium distinct strong brown (7.5YR 5/6) and few fine prominent dark gray (10YR 4/1) mottles; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; few fine black concretions of iron and manganese; slight effervescence in the lower part; mildly alkaline; clear wavy boundary.

C2—36 to 60 inches; light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) stratified fine sandy loam, loamy fine sand, and loamy very fine sand, pale yellow (2.5Y 7/4) and light gray (2.5Y 7/2) dry; many fine and medium prominent strong brown (7.5YR 5/6), yellowish brown (10YR 5/6), very dark brown (10YR 2/2), and olive gray (5Y 5/2) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; few fine concretions of iron and manganese; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. It is fine sandy loam, loam, or silt loam. The C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. Strata of fine sand are below a depth of 30 inches in some pedons.

In the map unit Glyndon-Tiffany silt loams, the Tiffany soil contains more silt and less sand than is defined as the range for the Tiffany series. Also, the map unit Tiffany loam contains more clay than is defined as the range for the series. These differences, however, do not alter the use or behavior of the soils.

Tonka series

The Tonka series consists of deep, poorly drained, slowly permeable soils on till plains and in areas between beach ridges. These soils formed in medium textured and moderately fine textured colluvium overlying till. Slope is 0 to 1 percent.

Tonka soils are similar to Parnell soils and are commonly adjacent to Antler, Hamerly, Parnell, and Vallers soils on the landscape. Parnell soils do not have an albic horizon. They are very poorly drained. Antler,

Hamerly, and Vallers soils have a calcic horizon within a depth of 16 inches. Also, Antler and Hamerly soils are somewhat poorly drained.

Typical pedon of Tonka silt loam, in an area of Antler-Tonka silt loams, 730 feet west and 740 feet north of the southeast corner of sec. 2, T. 149 N., R. 51 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; neutral; abrupt smooth boundary.

A12—7 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; neutral; clear irregular boundary.

A2—11 to 19 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 6/1) dry; common fine distinct dark reddish brown (5YR 3/2) mottles; moderate fine platy structure; soft, very friable, sticky and plastic; few very fine roots; uncoated sand grains on faces of peds; about 5 percent pebbles; neutral; clear wavy boundary.

B21t—19 to 25 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, dark gray (10YR 4/1) dry; common medium distinct grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to moderate fine angular blocky; slightly hard, friable, sticky and plastic; few very fine roots; common thin clay films on faces of peds; neutral; gradual wavy boundary.

B22t—25 to 34 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to moderate fine angular blocky; slightly hard, friable, sticky and plastic; few thin clay films on faces of peds; neutral; clear wavy boundary.

C—34 to 60 inches; gray (5Y 5/1) clay loam, light gray (5Y 7/2) dry; common medium distinct brownish yellow (10YR 6/6) and many medium prominent dark reddish brown (5YR 3/3) mottles; massive; hard, firm, sticky and plastic; thin cobble line in the upper part; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to more than 50 inches. The Ap and A1 horizons have hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. The Ap horizon is silt loam or silty clay loam. The A2 horizon has hue of 10YR, 2.5Y, or neutral, value of 3 or 4 (5 to 7 dry), and chroma of 2 or less. It typically is silt loam but in some pedons is very fine sandy loam, loam, or silty clay loam. It has few to many, distinct or prominent mottles. The B horizon has hue of 10YR to 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or 2. It typically is silty clay loam but in some pedons is clay loam, clay, or silty clay. It has few to many, distinct or prominent mottles. The C horizon typically is clay loam, but the range includes silty clay loam and loam.

Towner series

The Towner series consists of deep, moderately well drained soils that are rapidly permeable in the upper part and are moderately slowly permeable in the lower part of the substratum. These soils are on beaches. They formed in coarse textured glaciolacustrine deposits overlying medium textured and moderately fine textured till and glaciolacustrine deposits. Slope ranges from 1 to 3 percent.

Towner soils are commonly adjacent to Grimstad, Hamar, Hecla, and Tiffany soils on the landscape. Grimstad soils have a calcic horizon within a depth of 16 inches. They are somewhat poorly drained. Hamar, Hecla, and Tiffany soils do not have a medium textured or moderately fine textured IIC horizon. Hamar and Tiffany soils are poorly drained. Also, Tiffany soils contain more clay in the upper part than the Towner soils.

Typical pedon of Towner fine sandy loam, 1 to 3 percent slopes, 1,270 feet south and 320 feet east of the northwest corner of sec. 33, T. 149 N., R. 51 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

A12—8 to 12 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; clear smooth boundary.

A13—12 to 18 inches; very dark brown (10YR 2/2) loamy fine sand, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; mildly alkaline; clear smooth boundary.

C1—18 to 27 inches; dark grayish brown (10YR 4/2) fine sand, brown (10YR 5/3) dry; few fine distinct dark brown (7.5YR 4/4) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few fine dark reddish brown (5YR 3/4) concretions of iron and manganese; mildly alkaline; gradual wavy boundary.

C2—27 to 31 inches; olive brown (2.5Y 4/4) fine sand, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark brown (7.5YR 4/4) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; thin cobble line in the lower part; few fine dark reddish brown (5YR 3/4) concretions of iron and manganese; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIC3ca—31 to 39 inches; light brownish gray (2.5Y 6/2) silty clay loam, light gray (2.5Y 7/2) dry; common fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; about 10 percent pebbles; few fine dark reddish brown (5YR 3/4) concretions of iron and manganese; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

IIC4—39 to 60 inches; light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) silty clay loam, pale yellow (2.5Y 7/4) and light yellowish brown (2.5Y 6/4) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; very hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The depth to the IIC horizon ranges from 20 to 40 inches.

The Ap horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The C horizon typically is fine sand, but the range includes loamy sand and loamy fine sand. The IIC horizon typically is silty clay loam, but the range includes clay loam, silt loam, and loam.

Vallers series

The Vallers series consists of deep, poorly drained, moderately slowly permeable soils on till plains and in areas between beach ridges. These soils formed in medium textured and moderately fine textured till, glaciolacustrine deposits overlying till, and alluvium. Slope is 0 to 1 percent.

Vallers soils are commonly adjacent to Antler, Hamerly, Manfred, and Parnell soils on the landscape. Antler and Hamerly soils are somewhat poorly drained. Manfred soils have a natric horizon. Parnell soils do not have a calcic horizon within a depth of 16 inches and have an argillic horizon. They are very poorly drained.

Typical pedon of Vallers loam, 1,250 feet south and 500 feet west of the northeast corner of sec. 6, T. 154 N., R. 56 W.

Ap—0 to 8 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—8 to 14 inches; dark gray (10YR 4/1) clay loam, gray (10YR 6/1) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—14 to 24 inches; light olive gray (5Y 6/2) clay loam, light gray (5Y 7/1) dry; few fine prominent reddish brown (5YR 4/4) and few fine distinct light olive brown (2.5Y 5/6) and dark reddish brown (5YR 3/2) mottles; weak fine subangular blocky structure; hard, friable, sticky and plastic; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C3ca—24 to 44 inches; olive gray (5Y 5/2) clay loam, light olive gray (5Y 6/2) dry; few fine distinct dark brown (10YR 4/3) mottles; weak fine subangular blocky structure; hard, friable, sticky and plastic; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C4—44 to 60 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; few fine distinct black (10YR 2/1) and olive brown (2.5Y 4/4) mottles; massive; very hard, firm, sticky and plastic; slight effervescence; moderately alkaline.

These soils typically are nonsaline but are slightly or moderately saline in some areas. The thickness of the mollic epipedon ranges from 7 to 22 inches. In some pedons the calcic horizon includes the lower part of the mollic epipedon.

The A horizon has hue of 10YR or neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. It is loam or clay loam. In slightly and moderately saline areas, it has few or common segregated masses of salt crystals. The Cca horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 or 2. The C horizon typically is clay loam, but the range includes loam.

Vang series

The Vang series consists of deep, well drained soils that are moderately permeable in the upper part and are rapidly permeable in the lower part of the substratum. These soils are on delta plains and stream terraces. They are moderately deep over sand and gravel. They formed in medium textured and moderately fine textured deposits overlying coarse textured glaciofluvial deposits that are dominantly shale. Slope ranges from 0 to 3 percent.

Vang soils are commonly adjacent to Embden, Inkster, Renshaw, Sioux, and Walsh soils on the landscape. Embden and Inkster soils contain less clay in the solum than the Vang soils and lack a IIC horizon. Renshaw soils have a mollic epipedon that is less than 16 inches thick and have a IIC horizon of sand and gravel at a depth of 14 to 20 inches. Sioux soils do not have a B horizon and are shallow and very shallow over sand and gravel. Walsh soils do not have a IIC horizon within a depth of 40 inches.

Typical pedon of Vang loam, 0 to 3 percent slopes, 1,885 feet west and 1,755 feet north of the southeast corner of sec. 1, T. 154 N., R. 56 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular and subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; about 3 percent pebbles; neutral; abrupt smooth boundary.

B2—10 to 22 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; few fine and medium distinct dark reddish brown (2.5YR 2/4) and few fine distinct dark olive gray (5Y 3/2) mottles; moderate medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, sticky and plastic; common very fine roots; cracks filled with black (N 2/0) material in the upper 5 inches; about 1 percent pebbles; neutral; clear wavy boundary.

C1—22 to 35 inches; dark grayish brown (2.5Y 4/2) sandy clay loam, light brownish gray (2.5Y 6/2) dry; common fine distinct dusky red (2.5YR 3/2) and black (5Y 2/2) mottles; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; about 8 percent pebbles; mildly alkaline; clear wavy boundary.

IIC2—35 to 48 inches; very dark grayish brown (2.5Y 3/2) very shaly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; about 55 percent pebbles; slight effervescence; moderately alkaline; clear wavy boundary.

IIC3—48 to 60 inches; very dark grayish brown (2.5Y 3/2) coarse sand, grayish brown (2.5Y 5/2) dry; loose, nonsticky and nonplastic; about 15 percent pebbles; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 16 to 30 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. It typically is clay loam, but the range includes loam. Some pedons have a Cca horizon. The C horizon typically is sandy clay loam, but the range includes loam and clay loam.

Velva series

The Velva series consists of deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in moderately coarse textured alluvium. Slope ranges from 1 to 3 percent.

Velva soils are commonly adjacent to LaDelle, Lamoure, and Rauville soils on the landscape. The adjacent soils contain more clay and less sand throughout than the Velva soils. Also, Lamoure soils are poorly drained and Rauville soils very poorly drained.

Typical pedon of Velva sandy loam, 1 to 3 percent slopes, 800 feet west and 140 feet south of the northeast corner of sec. 32, T. 152 N., R. 54 W.

A1—0 to 7 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine, medium, and coarse roots; slight effervescence; neutral; clear wavy boundary.

B2—7 to 15 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak very fine and fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots; slight effervescence; moderately alkaline; clear wavy boundary.

C1—15 to 32 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots; slight effervescence; moderately alkaline; abrupt wavy boundary.

C2—32 to 48 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots; strong effervescence; moderately alkaline; abrupt wavy boundary.

C3—48 to 56 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; abrupt wavy boundary.

IIC4—56 to 60 inches; dark gray (10YR 4/1) sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It typically is sandy loam, but the range includes fine sandy loam. Some pedons do not have a B horizon. Some have a buried A horizon.

Wahpeton series

The Wahpeton series consists of deep, moderately well drained, moderately slowly permeable soils on flood plains. These soils formed in fine textured alluvium. Slope ranges from 1 to 3 percent.

Wahpeton soils are similar to Nutley soils and are commonly adjacent to Cashel, Dovray, LaDelle, and Nutley soils on the landscape. Nutley soils have a mollic epipedon that is less than 21 inches thick. They are well drained. Cashel soils do not have a mollic epipedon. Dovray soils are poorly drained. LaDelle soils contain less clay throughout than the Wahpeton soils.

Typical pedon of Wahpeton silty clay, 1 to 3 percent slopes, 2,465 feet west and 260 feet north of the southeast corner of sec. 2, T. 154 N., R. 51 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; very hard, friable, very sticky and very plastic; many very fine roots; mildly alkaline; abrupt smooth boundary.

A12—6 to 29 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; very hard, friable, very sticky and very plastic; few very fine roots; faces of peds are slick and shiny when moist; mildly alkaline; clear irregular boundary.

C1—29 to 36 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium angular and subangular blocky structure; very hard, friable, very sticky and very plastic; few very fine roots; mildly alkaline; clear wavy boundary.

C2—36 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct brown (10YR 4/3) and dark yellowish brown (10YR 3/4) mottles; massive; very hard, firm, very sticky and very plastic; common fine and medium masses of lime; strong effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 24 to 50 inches. When the soil is dry, vertical cracks half an inch to 2 inches wide and several feet long extend through the solum.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The C horizon typically is silty clay and silty clay loam, but the range includes clay. Some pedons have a buried A horizon below a depth of 24 inches.

Walsh series

The Walsh series consists of deep, moderately well drained, moderately permeable soils on delta plains. These soils formed in medium textured and moderately fine textured glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Walsh soils are similar to Svea soils and are commonly adjacent to Embden, Inkster, Tiffany, and Vang soils on the landscape. Svea soils have a Cca horizon and formed in till. Embden and Inkster soils contain less clay throughout than the Walsh soils. Tiffany soils are poorly drained. They contain less clay than the Walsh soils. Vang soils have a IIC horizon of sand and gravel.

Typical pedon of Walsh loam, 0 to 3 percent slopes, 1,400 feet east and 1,400 feet north of the southwest corner of sec. 18, T. 154 N., R. 55 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; abrupt smooth boundary.

A12—9 to 18 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; clear wavy boundary.

B21—18 to 28 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; clear wavy boundary.

B22—28 to 40 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; few fine distinct black (10YR 2/1) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral; abrupt wavy boundary.

C1—40 to 46 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; common medium distinct dark yellowish brown (10YR 3/4) and common fine distinct dark reddish brown (5YR 3/3) mottles; weak fine and medium angular blocky structure; hard, friable, sticky and plastic; few very fine roots; neutral; clear wavy boundary.

C2—46 to 60 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; common fine distinct dark reddish brown (5YR 3/3) mottles; weak fine and medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; neutral.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 to 5 (3 to 6 dry), and chroma of 1 to 3. It typically is loam, but the range includes clay loam, silt loam, and silty clay loam. The C horizon typically is clay loam and silty clay loam, but the range includes silt loam and loam. Some pedons have thin strata of sand or shaly sand below a depth of 40 inches. Some pedons have disseminated lime in the lower part of the C horizon.

Wyndmere series

The Wyndmere series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on beaches and delta plains. These soils formed in moderately coarse textured and coarse textured glaciofluvial and glaciolacustrine deposits. Slope is 0 to 1 percent.

Wyndmere soils are commonly adjacent to Arveson, Embden, Glyndon, Inkster, and Tiffany soils on the landscape. Arveson and Tiffany soils are poorly drained. Embden, Inkster, and Tiffany soils do not have a calcic

horizon within a depth of 16 inches. Glyndon soils contain less sand than the Wyndmere soils.

Typical pedon of Wyndmere sandy loam, 2,265 feet south and 450 feet east of the northwest corner of sec. 20, T. 154 N., R. 54 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

C1ca—10 to 19 inches; gray (10YR 5/1) sandy loam, light gray (10YR 7/1) dry; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—19 to 28 inches; grayish brown (10YR 5/2) sandy loam, light gray (10YR 7/2) dry; weak coarse prismatic structure parting to weak fine subangular and angular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C3—28 to 38 inches; brown (10YR 5/3) loamy fine sand, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; slight effervescence; moderately alkaline; clear wavy boundary.

C4—38 to 60 inches; pale brown (10YR 6/3) fine sand, very pale brown (10YR 7/3) dry; common medium prominent red (2.5YR 4/6) and common fine and medium distinct dark brown (7.5YR 4/4) and light gray (10YR 7/1) mottles; massive; soft, very friable, nonsticky and nonplastic; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is sandy loam or fine sandy loam. The Cca horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2. It typically is sandy loam, but the range includes fine sandy loam. The part of the C horizon below the Cca horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It has few to many, distinct or prominent mottles. It typically is fine sand and loamy fine sand, but the range includes loamy very fine sand. Some pedons have strata of sand and gravel, loam, silt loam, or clay loam below a depth of 40 inches.

Zell series

The Zell series consists of deep, well drained, moderately permeable soils on glacial lake plains and in areas between beach ridges. These soils formed in medium textured glaciolacustrine deposits. Slope ranges from 3 to 15 percent.

Zell soils are similar to Buse soils and are commonly adjacent to Gardena, LaDelle, Lamoure, Rauville, and Tiffany soils on the landscape. Buse soils formed in till. They have a higher content of coarse sand and clay than the Zell soils. Gardena and LaDelle soils have a mollic epipedon that is more than 16 inches thick. Lamoure and Tiffany soils are poorly drained, and Rauville soils are very poorly drained. Also, Tiffany soils contain more sand than the Zell soils.

Typical pedon of Zell silt loam, in an area of Zell-Gardena silt loams, 1 to 6 percent slopes, 1,310 feet east and 825 feet north of the southwest corner of sec. 1, T. 153 N., R. 54 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—9 to 23 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak fine and medium subangular blocky and weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C2—23 to 36 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; moderately alkaline; clear wavy boundary.

C3—36 to 60 inches; olive brown (2.5Y 4/4) very fine sandy loam, pale yellow (2.5Y 7/4) dry; few fine distinct dark yellowish brown (10YR 4/4) and dark brown (10YR 3/3) mottles; massive; soft, very friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 13 inches. In the 10- to 40-inch control section, the content of clay is less than 18 percent and of fine sand or coarser sand less than 15 percent.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The C horizon has hue of 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It typically is very fine sandy loam, but the range includes silt loam. Also, the lower part has strata of silty clay loam in some pedons.

In the map units Zell-LaDelle silt loams, 1 to 6 percent slopes, Zell-LaDelle silt loams, 1 to 9 percent slopes, and Zell-LaDelle silt loams, 1 to 15 percent slopes, the Zell soil contains more clay than is defined as the range for the Zell series. This difference, however, does not alter the use or behavior of the soils.

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glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Beaches. In this survey area, a series of low, essentially continuous ridges heaped up by the wave action of Glacial Lake Agassiz.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Delta plains. Plains formed by the accumulation of principally coarse to medium textured glaciofluvial deposits. Delta plains are commonly smooth; where they are pitted with depressions, relief generally is low.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on

the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial lake plains. In this survey area, plains formed by the accumulation of principally medium to moderately fine textured glaciolacustrine deposits of Glacial Lake Agassiz.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Interbeach areas. Plains formed by the accumulation of glaciolacustrine deposits overlying till and separated by narrow, commonly multiple beaches.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Low strength. The soil is not strong enough to support loads.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium. Classes of salinity are based on the electrical conductivity of the saturation extract at 25 degrees C. Five classes are recognized:

Nonsaline.—The electrical conductivity is 0 to 2 millimhos per centimeter. The effect of salinity on yields generally is negligible.

Slightly saline.—The electrical conductivity is 2 to 4 millimhos per centimeter. The salinity may restrict the yields of very sensitive crops.

Moderately saline.—The electrical conductivity is 4 to 8 millimhos per centimeter. The salinity restricts the yields of many crops.

Strongly saline.—The electrical conductivity is 8 to 16 millimhos per centimeter. Only salt tolerant crops yield satisfactorily.

Very strongly saline.—The electrical conductivity is more than 16 millimhos per centimeter. Only a few, very salt tolerant crops yield satisfactorily.

Scalp planting. Planting trees and shrubs in trenches in uncultivated areas. These areas generally support native grass and brush and commonly are highly susceptible to soil blowing and water erosion.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Seepy areas. Areas of ground water discharge that generally are adjacent to and parallel with beaches. These areas are characterized by intermittent or continual surface wetness.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-77 at Grand Forks, N. Dak.]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	12.1	-7.0	2.5	41	-34	0	.78	.31	1.15	3	8.5
February---	19.8	.1	10.0	44	-28	0	.49	.20	.72	2	4.7
March------	31.6	12.8	22.2	60	-23	43	.76	.28	1.14	3	6.8
April------	50.4	30.8	40.6	82	6	142	1.34	.46	2.04	4	2.6
May--------	66.9	41.3	54.1	93	22	447	1.97	.70	2.98	5	.3
June-------	76.1	51.7	63.9	96	34	717	3.03	1.66	4.14	6	.0
July-------	81.6	55.8	68.7	99	40	890	2.89	1.39	4.10	6	.0
August-----	80.3	53.8	67.1	99	37	840	2.51	1.14	3.63	6	.0
September--	68.1	43.7	55.9	94	26	477	2.03	.65	3.12	4	.0
October----	56.2	33.8	45.0	84	14	221	1.12	.37	1.71	3	.4
November---	34.8	18.2	26.6	63	-12	17	.82	.22	1.30	3	5.7
December---	19.4	2.2	10.8	44	-28	0	.68	.35	.94	3	6.6
Yearly:											
Average--	49.8	28.7	39.0	---	---	---	---	---	---	---	---
Extreme--	---	---	---	100	-34	---	---	---	---	---	---
Total----	---	---	---	---	---	3,794	18.42	15.21	21.47	48	35.6

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-77 at Grand Forks, N. Dak.]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 4	May 20	June 3
2 years in 10 later than--	April 29	May 14	May 29
5 years in 10 later than--	April 19	May 2	May 20
First freezing temperature in fall:			
1 year in 10 earlier than--	October 1	September 16	August 22
2 years in 10 earlier than--	October 6	September 22	August 30
5 years in 10 earlier than--	October 16	October 3	September 16

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-77 at Grand Forks, N. Dak.]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	162	127	93
8 years in 10	168	136	102
5 years in 10	179	153	118
2 years in 10	191	170	134
1 year in 10	197	179	143

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Parnell silt loam	3,360	0.4
3	Vallers loam	9,050	1.0
4	Arveson loam	11,110	1.2
8	Colvin silty clay loam	3,180	0.3
10	Lamoure silty clay loam	5,540	0.6
11	Dovray clay	840	0.1
12	Svea loam, 0 to 3 percent slopes	29,550	3.2
13B	Barnes loam, 3 to 6 percent slopes	12,100	1.3
15D	Buse-Svea loams, 1 to 15 percent slopes	4,600	0.5
15E	Buse-Svea loams, 1 to 25 percent slopes	2,230	0.2
16	Lallie silty clay loam, ponded	2,790	0.3
17	Vang loam, 0 to 3 percent slopes	910	0.1
19	Hamerly loam, 1 to 3 percent slopes	9,390	1.0
23	Cresbard-Cavour loams, 0 to 3 percent slopes	18,740	2.0
23B	Barnes-Cresbard loams, 1 to 6 percent slopes	22,310	2.4
25	Overly silty clay loam, 0 to 3 percent slopes	8,640	0.9
26	Bearden-Overly silty clay loams, 0 to 3 percent slopes	9,610	1.0
29	Velva sandy loam, 1 to 3 percent slopes	3,530	0.4
30	Walsh loam, 0 to 3 percent slopes	5,100	0.6
35	Rauville silt loam	4,610	0.5
39	Vallers-Manfred clay loams, saline	9,850	1.1
41	Bearden-Perella silty clays	12,360	1.3
42	Nutley silty clay	3,210	0.3
43B	Cashel silty clay loam, 1 to 6 percent slopes	5,810	0.6
43E	Cashel silty clay loam, 6 to 25 percent slopes	3,040	0.3
45	Wahpeton silty clay, 1 to 3 percent slopes	3,220	0.3
46	LaDelle silt loam, 0 to 3 percent slopes	13,390	1.5
48	Wyndmere sandy loam	10,910	1.2
50B	Hecla fine sandy loam, 1 to 6 percent slopes	8,750	1.0
51B	Hecla-Maddock fine sandy loams, 1 to 6 percent slopes	8,000	0.9
51E	Maddock sandy loam, 9 to 25 percent slopes	800	0.1
53	Hamar sandy loam	3,580	0.4
54B	Embden fine sandy loam, 1 to 6 percent slopes	24,530	2.7
55	Tiffany loam	4,630	0.5
59	Towner fine sandy loam, 1 to 3 percent slopes	1,400	0.2
60	Grimstad fine sandy loam	3,380	0.4
62	Rockwell fine sandy loam	1,660	0.2
64	Antler silt loam	29,690	3.2
65	Antler silty clay loam, saline	27,250	3.0
67	Gilby loam	24,170	2.6
70	Antler-Tonka silty clay loams, saline	4,830	0.5
71	Hamerly-Tonka complex, 0 to 3 percent slopes	8,970	1.0
72	Gardena silt loam, 0 to 3 percent slopes	15,830	1.7
73	Glyndon silt loam, 0 to 3 percent slopes	39,340	4.3
76	Borup silt loam	1,960	0.2
78B	Zell-Gardena silt loams, 1 to 6 percent slopes	1,920	0.2
78C	Zell-Gardena silt loams, 1 to 9 percent slopes	1,530	0.2
79B	Zell-LaDelle silt loams, 1 to 6 percent slopes	5,050	0.5
79C	Zell-LaDelle silt loams, 1 to 9 percent slopes	3,490	0.4
79D	Zell-LaDelle silt loams, 1 to 15 percent slopes	2,350	0.3
84	Wyndmere-Embden sandy loams	4,840	0.5
86	Divide loam, 1 to 3 percent slopes	4,680	0.5
87	Marysland loam	6,270	0.7
89	Renshaw loam, 1 to 3 percent slopes	6,620	0.7
89B	Renshaw loam, 3 to 6 percent slopes	2,550	0.3
90B	Arvilla sandy loam, 1 to 6 percent slopes	24,120	2.6
93	Inkster sandy loam, 0 to 3 percent slopes	18,610	2.0
94	Pits, gravel	1,130	0.1
95	Ojata silty clay loam	40,430	4.4
96D	Sioux-Barnes loams, 6 to 15 percent slopes	1,880	0.2
97D	Sioux loam, 1 to 15 percent slopes	8,840	1.0
98E	Edgeley-Kloten loams, 6 to 25 percent slopes	4,110	0.4
99	Cavour-Miranda loams, 0 to 3 percent slopes	3,500	0.4
126	Bearden silty clay loam	83,830	9.1
130B	Svea-Buse loams, 1 to 6 percent slopes	41,940	4.6
130C	Buse-Svea loams, 1 to 9 percent slopes	13,090	1.4
148	Wyndmere-Tiffany fine sandy loams	20,140	2.2
171	Antler-Tonka silt loams	27,170	3.0
173	Glyndon-Tiffany silt loams	16,160	1.8
199D	Miranda Variant loam, 1 to 15 percent slopes	440	*

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
226	Bearden-Perella silty clay loams	23,420	2.5
270	Bearden silty clay loam, saline	111,110	12.1
401	Aberdeen-Nutley silty clays	2,090	0.2
402	Exline-Aberdeen silty clays	610	0.1
	Water	650	0.1
	Total	920,320	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Only arable soils are listed. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Spring wheat	Barley	Sunflowers	Irish potatoes	Sugar beets	Grass-legume hay
	Bu	Bu	Lb	Cwt	Ton	Ton
3 Vallers	17	27	1,100	---	---	1.4
4* Arveson	24	38	1,250	---	---	2.2
8* Colvin	33	53	1,250	130	12.5	2.9
10 Lamoure	20	32	700	---	---	1.8
11* Dovray	33	53	1,250	130	11.5	2.9
12 Svea	38	61	1,800	---	---	2.9
13B Barnes	33	53	1,450	---	---	2.6
17 Vang	29	46	950	---	---	2.6
19 Hamerly	34	55	1,550	---	---	2.7
23 Cresbard-Cavour	23	37	900	---	---	1.9
23B Barnes-Cresbard	30	48	1,300	---	---	2.5
25 Overly	45	72	1,900	190	18.0	4.0
26 Bearden-Overly	44	70	1,850	185	17.5	4.0
29 Velva	29	46	1,800	---	---	2.6
30 Walsh	41	66	1,900	170	16.0	3.6
41* Bearden-Perella	38	61	1,650	150	13.5	3.5
42 Nutley	40	64	1,700	140	16.0	3.4
43B Cashel	38	61	1,500	150	14.5	3.3
45 Wahpeton	43	69	1,900	140	17.0	3.8
46 LaDelle	45	72	1,900	190	18.0	4.0

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Sunflowers	Irish potatoes	Sugar beets	Grass-legume hay
	Bu	Bu	Lb	Cwt	Ton	Ton
48----------------------- Wyndmere	33	53	1,600	130	---	2.9
50B---------------------- Hecla	24	38	1,350	---	---	2.2
51B---------------------- Hecla-Maddock	21	34	1,150	---	---	1.9
53*---------------------- Hamar	23	37	1,600	---	---	2.0
54B---------------------- Embden	34	55	1,800	135	---	3.0
55*---------------------- Tiffany	32	51	1,700	120	---	2.7
59----------------------- Towner	27	43	1,350	110	---	2.4
60----------------------- Grimstad	29	46	1,425	---	---	2.6
62*---------------------- Rockwell	27	43	1,350	---	---	2.4
64----------------------- Antler	41	66	1,700	---	---	3.6
65----------------------- Antler	29	46	550	---	---	2.6
67----------------------- Gilby	41	66	1,700	170	---	3.6
70*---------------------- Antler-Tonka	31	49	830	---	---	2.6
71*---------------------- Hamerly-Tonka	27	43	1,200	---	---	2.3
72----------------------- Gardena	45	72	1,900	190	18.0	4.0
73----------------------- Glyndon	43	69	1,700	180	17.5	3.8
76*---------------------- Borup	33	53	1,250	130	12.5	2.9
78B---------------------- Zell-Gardena	31	49	1,200	120	13.0	2.7
78C---------------------- Zell-Gardena	27	43	1,040	105	11.0	2.4
79B---------------------- Zell-LaDelle	32	51	1,200	120	13.0	2.7
79C---------------------- Zell-LaDelle	28	45	1,050	105	11.0	2.4

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Sunflowers	Irish potatoes	Sugar beets	Grass-legume hay
	Bu	Bu	Lb	Cwt	Ton	Ton
84------------------------ Wyndmere-Embden	33	55	1,700	135	---	3.0
86------------------------ Divide	32	51	950	---	---	2.6
87*----------------------- Marysland	24	38	1,050	---	---	2.2
89------------------------ Renshaw	21	34	650	---	---	1.9
89B----------------------- Renshaw	18	29	600	---	---	1.6
90B----------------------- Arvilla	20	32	600	---	---	1.8
93------------------------ Inkster	35	56	1,800	140	---	3.1
99------------------------ Cavour-Miranda	11	18	---	---	---	1.0
126----------------------- Bearden	43	69	1,700	180	17	3.8
130B---------------------- Svea-Buse	32	51	1,400	---	---	2.5
130C---------------------- Buse-Svea	24	38	1,125	---	---	2.0
148*---------------------- Wyndmere-Tiffany	32	52	1,625	130	---	2.7
171*---------------------- Antler-Tonka	38	61	1,500	---	---	3.3
173*---------------------- Glyndon-Tiffany	40	64	1,700	160	16.0	3.4
226*---------------------- Bearden-Perella	43	69	1,675	180	16.0	3.8
270----------------------- Bearden	32	51	1,550	120	13.5	2.7
401----------------------- Aberdeen-Nutley	33	53	1,400	130	12.5	2.9

* Yields are only for areas where surface drainage is adequate.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
2-----------------Parnell	American plum-----	Eastern redcedar, redosier dogwood, Siberian peashrub, common chokecherry, lilac, Tatarian honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow-----	Eastern cottonwood.
3. Vallers					
4-----------------Arveson	American plum-----	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
8-----------------Colvin	---	American plum, Siberian peashrub, common chokecherry, lilac, eastern redcedar, redosier dogwood, Tatarian honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow-----	Eastern cottonwood.
10----------------Lamoure	American plum-----	Eastern redcedar, redosier dogwood, Siberian peashrub, Tatarian honeysuckle, common chokecherry, lilac.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow-----	Eastern cottonwood.
11----------------Dovray	American plum-----	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
12----------------Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow-----	Eastern cottonwood.
13B---------------Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
15D*, 15E*: Buse.					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
16. Lallie					
17 Vang	Lilac, Siberian peashrub, Tatarian honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian-olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
19 Hamerly	---	Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Eastern cottonwood.
23*: Cresbard	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
23B*: Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
23B*:					
Cresbard	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
25 Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
26*:					
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
29 Velva	---	Ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster, redosier dogwood.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
30 Walsh	---	Tatarian honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
35. Rauville					
39*: Vallers.					
Manfred.					
41*: Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Perella	---	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
42 Nutley	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, eastern redcedar, common chokecherry, silver buffaloberry, Siberian peashrub, lilac.	Green ash, Siberian elm, ponderosa pine, Siberian crabapple.	---	---
43B Cashel	---	Redosier dogwood, ponderosa pine, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
43E. Cashel					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
45----------------- Wahpeton	---	Peking cotoneaster, ponderosa pine, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
46----------------- LaDelle	---	Ponderosa pine, Tatarian honeysuckle, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Black Hills spruce, green ash, Siberian crabapple.	Golden willow-----	Eastern cottonwood.
48----------------- Wyndmere	---	Redosier dogwood, ponderosa pine, American plum, Tatarian honeysuckle, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
50B---------------- Hecla	---	Ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster, redosier dogwood.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
51B*:					
Hecla--------------	---	Ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster, redosier dogwood.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
51B*: Maddock	---	Lilac, silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Tatarian honeysuckle, American plum, Siberian crabapple.	Green ash, ponderosa pine, Russian-olive.	---	---
51E. Maddock					
53 Hamar	American plum	Tatarian honeysuckle, redosier dogwood, common chokecherry, Siberian peashrub, lilac.	Black Hills spruce, green ash, Siberian crabapple, eastern redcedar.	Golden willow	Eastern cottonwood.
54B Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
55 Tiffany	---	Lilac, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub, Tatarian honeysuckle.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
59 Towner	---	Eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, Siberian peashrub, silver buffaloberry, Tatarian honeysuckle.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
60 Grimstad	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
62 Rockwell	Lilac, silver buffaloberry.	Tatarian honeysuckle, Siberian peashrub, redosier dogwood.	Ponderosa pine, Siberian crabapple, eastern redcedar, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
64 Antler	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
65 Antler	---	Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, Russian-olive.	---	---
67 Gilby	---	Tatarian honeysuckle, ponderosa pine, redosier dogwood, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
70*:					
Antler	---	Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, Russian-olive.	---	---
Tonka	---	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
71*: Hamerly	---	Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
72 Gardena	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
73 Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
76 Borup	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
78B*, 78C*: Zell	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Russian-olive, green ash, Rocky Mountain juniper, eastern redcedar.	Siberian elm	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
78B*, 78C*:					
Gardena	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
79B*, 79C*:					
Zell	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Russian-olive, green ash, Rocky Mountain juniper, eastern redcedar.	Siberian elm	---	---
LaDelle	---	Ponderosa pine, Tatarian honeysuckle, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Black Hills spruce, green ash, Siberian crabapple.	Golden willow	Eastern cottonwood.
79D*:					
Zell.					
LaDelle	---	Ponderosa pine, Tatarian honeysuckle, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Black Hills spruce, green ash, Siberian crabapple.	Golden willow	Eastern cottonwood.
84*:					
Wyndmere	---	Redosier dogwood, ponderosa pine, American plum, Tatarian honeysuckle, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
84*: Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
86 Divide	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
87 Marysland	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
89, 89B Renshaw	Silver buffaloberry, Tatarian honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
90B Arvilla	Tatarian honeysuckle, Siberian peashrub, lilac, silver buffaloberry.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---
93 Inkster	---	Eastern redcedar, Siberian peashrub, redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, common chokecherry, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
94*. Pits					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
95. Ojata					
96D*: Sioux.					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
97D. Sioux					
98E*: Edgeley	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Kloten.					
99*: Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
Miranda.					
126 Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
130B*: Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Buse.					
130C*: Buse.					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
130C*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
148*:					
Wyndmere	---	Redosier dogwood, ponderosa pine, American plum, Tatarian honeysuckle, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tiffany	---	Lilac, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub, Tatarian honeysuckle.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
171*:					
Antler	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
173*:					
Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Tiffany	---	Lilac, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub, Tatarian honeysuckle.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
199D. Miranda Variant					
226*:					
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Perella	---	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
270 Bearden	---	Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, Russian-olive.	---	---
401*:					
Aberdeen	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common hackberry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
401*:					
Nutley	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, eastern redcedar, common chokecherry, silver buffaloberry, Siberian peashrub, lilac.	Green ash, Siberian elm, ponderosa pine, Siberian crabapple.	---	---
402*:					
Exline.					
Aberdeen	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common hackberry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2: Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3: Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
4: Arveson	Severe: ponding.	Severe: excess humus, ponding.	Severe: excess humus, ponding.	Severe: excess humus.
8: Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
10: Lamoure	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
11: Dovray	Severe: ponding, too clayey, percs slowly.	Severe: ponding, too clayey, percs slowly.	Severe: ponding, too clayey, percs slowly.	Severe: too clayey, ponding.
12: Svea	Slight	Slight	Slight	Slight.
13B: Barnes	Slight	Slight	Moderate: slope.	Slight.
15D*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.
15E*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Svea	Slight	Slight	Moderate: slope.	Slight.
16: Lallie	Severe: ponding, excess salt.	Severe: ponding, excess salt.	Severe: ponding, excess salt.	Severe: ponding, erodes easily.
17: Vang	Slight	Slight	Slight	Slight.
19: Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.
23*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Severe: erodes easily.
23B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
23B*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
25 Overly	Slight	Slight	Slight	Slight.
26*:				
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.
Overly	Slight	Slight	Moderate: slope.	Slight.
29 Velva	Severe: floods.	Slight	Moderate: floods.	Slight.
30 Walsh	Slight	Slight	Moderate: small stones.	Slight.
35 Rauville	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
39*:				
Vallers	Severe: floods, wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
Manfred	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding.
41*:				
Bearden	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
Perella	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
42 Nutley	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: percs slowly.	Moderate: too clayey.
43B Cashel	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
43E Cashel	Severe: floods, slope, wetness.	Severe: slope.	Severe: slope, wetness.	Moderate: wetness, slope.
45 Wahpeton	Severe: floods.	Moderate: too clayey.	Moderate: slope, too clayey, floods.	Moderate: too clayey.
46 LaDelle	Severe: floods.	Slight	Moderate: floods.	Slight.
48 Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
50B: Hecla	Slight	Slight	Moderate: slope.	Slight.
51B*:				
Hecla	Slight	Slight	Moderate: slope.	Slight.
Maddock	Slight	Slight	Moderate: slope.	Slight.
51E: Maddock	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
53: Hamar	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
54B: Embden	Slight	Slight	Moderate: slope.	Slight.
55: Tiffany	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
59: Towner	Slight	Slight	Moderate: slope.	Slight.
60: Grimstad	Slight	Slight	Slight	Slight.
62: Rockwell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
64: Antler	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
65: Antler	Severe: wetness, excess salt.	Severe: excess salt.	Severe: wetness, excess salt.	Moderate: wetness.
67: Gilby	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
70*:				
Antler	Severe: wetness, excess salt.	Severe: excess salt.	Severe: wetness, excess salt.	Moderate: wetness.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
71*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
72: Gardena	Slight	Slight	Slight	Slight.
73: Glyndon	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
76 Borup	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
78B*:				
Zell	Slight	Slight	Moderate: slope.	Slight.
Gardena	Slight	Slight	Moderate: slope.	Slight.
78C*:				
Zell	Slight	Slight	Severe: slope.	Slight.
Gardena	Slight	Slight	Moderate: slope.	Slight.
79B*:				
Zell	Slight	Slight	Moderate: slope.	Slight.
LaDelle	Slight	Slight	Moderate: slope.	Slight.
79C*:				
Zell	Slight	Slight	Severe: slope.	Slight.
LaDelle	Slight	Slight	Moderate: slope.	Slight.
79D*:				
Zell	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
LaDelle	Slight	Slight	Moderate: slope.	Slight.
84*:				
Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Embden	Slight	Slight	Slight	Slight.
86 Divide	Slight	Slight	Moderate: slope.	Slight.
87 Marysland	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
89, 89B Renshaw	Slight	Slight	Moderate: slope.	Slight.
90B Arvilla	Slight	Slight	Moderate: slope.	Slight.
93 Inkster	Slight	Slight	Slight	Slight.
94*. Pits				
95 Ojata	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
96D*:				
Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
97D Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
98E*:				
Edgeley	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Kloten	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Moderate: slope.
99*:				
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Severe: erodes easily.
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
126 Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.
130B*:				
Svea	Slight	Slight	Moderate: slope.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
130C*:				
Buse	Slight	Slight	Severe: slope.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.
148*:				
Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Tiffany	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
171*:				
Antler	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
173*:				
Glyndon	Slight	Slight	Slight	Slight.
Tiffany	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
199D Miranda Variant	Severe: percs slowly.	Severe: percs slowly.	Severe: slope, percs slowly.	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
226*:				
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.
Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
270 Bearden	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Moderate: wetness.
401*:				
Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Nutley	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: percs slowly.	Moderate: too clayey.
402*:				
Exline	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Moderate: too clayey.
Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife
2----------------- Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good.
3----------------- Vallers	Poor	Fair	Fair	Fair	Good	Good	Fair	Good.
4----------------- Arveson	Fair	Fair	Good	Fair	Good	Good	Fair	Good.
8----------------- Colvin	Good	Good	---	---	Good	Good	Good	Good.
10---------------- Lamoure	Poor	Poor	Fair	---	Fair	Fair	Poor	Fair.
11---------------- Dovray	Poor	Poor	Poor	Poor	Good	Good	Poor	Good.
12---------------- Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor.
13B--------------- Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor.
15D*:								
Buse--------------	Fair	Fair	Fair	Fair	Very poor.	Very poor	Fair	Very poor.
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor.
15E*:								
Buse--------------	Poor	Poor	Fair	Fair	Very poor.	Very poor	Poor	Very poor.
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor.
16---------------- Lallie	Very poor	Very poor	Poor	Very poor.	Good	Good	Very poor	Good.
17---------------- Vang	Good	Good	Good	Fair	Poor	Poor	Good	Poor.
19---------------- Hamerly	Good	Good	Good	Fair	Fair	Poor	Good	Poor.
23*:								
Cresbard----------	Good	Fair	Good	---	Very poor.	Very poor	Good	Very poor.
Cavour------------	Poor	Poor	Poor	---	Very poor.	Very poor	Poor	Very poor.
23B*:								
Barnes------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor.
Cresbard----------	Fair	Fair	Good	---	Very poor.	Very poor	Fair	Very poor.
25---------------- Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor.
26*:								
Bearden-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife
26*:								
Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor.
29 Velva	Fair	Good	Fair	Good	Poor	Very poor	Fair	Very poor.
30 Walsh	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor.
35 Rauville	Very poor	Poor	Fair	---	Fair	Fair	Very poor	Fair.
39*:								
Vallers	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good.
Manfred	Poor	Poor	Fair	Poor	Good	Good	Poor	Good.
41*:								
Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
Perella	Good	Good	Good	Fair	Good	Good	Good	Good.
42 Nutley	Good	Fair	Fair	---	Poor	Very poor	Fair	Very poor.
43B Cashel	Good	Good	Fair	Poor	Poor	Fair	Fair	Poor.
43E Cashel	Poor	Fair	Good	Good	Very poor.	Very poor	Fair	Very poor.
45 Wahpeton	Good	Good	Fair	Poor	Poor	Poor	Fair	Poor.
46 LaDelle	Good	Good	Fair	---	Very poor.	Very poor	Good	Very poor.
48 Wyndmere	Fair	Good	Good	Fair	Fair	Poor	Good	Poor.
50B Hecla	Fair	Good	Good	---	Fair	Very poor	Good	Very poor.
51B*:								
Hecla	Fair	Good	Good	---	Fair	Very poor	Good	Very poor.
Maddock	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor.
51E Maddock	Poor	Fair	Good	Fair	Very poor.	Very poor	Fair	Very poor.
53 Hamar	Poor	Good	Fair	---	Fair	Fair	Fair	Fair.
54B Embden	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor.
55 Tiffany	Good	Good	Good	Fair	Good	Fair	Good	Fair.
59 Towner	Fair	Good	Good	Fair	Poor	Poor	Good	Poor.
60 Grimstad	Fair	Good	Fair	---	Fair	Fair	Fair	Fair.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife
62----- Rockwell	Fair	Fair	Good	Fair	Good	Good	Fair	Good.
64----- Antler	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
65----- Antler	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair.
67----- Gilby	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
70*:								
Antler-----	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair.
Tonka-----	Good	Good	Fair	Poor	Good	Good	Good	Good.
71*:								
Hamerly-----	Good	Good	Good	Fair	Fair	Poor	Good	Poor.
Tonka-----	Good	Good	Fair	Poor	Good	Good	Good	Good.
72----- Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor.
73----- Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor.
76----- Borup	Fair	Fair	Fair	Fair	Good	Good	Fair	Good.
78B*:								
Zell-----	Poor	Fair	Fair	---	Very poor.	Very poor	Poor	Very poor.
Gardena-----	Good	Good	Good	Fair	Poor	Poor	Good	Poor.
78C*:								
Zell-----	Poor	Fair	Fair	---	Very poor.	Very poor	Poor	Very poor.
Gardena-----	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor.
79B*, 79C*:								
Zell-----	Poor	Fair	Fair	---	Very poor.	Very poor	Poor	Very poor.
LaDelle-----	Good	Good	Good	---	Very poor.	Very poor	Good	Very poor.
79D*:								
Zell-----	Very poor	Fair	Fair	---	Very poor.	Very poor	Very poor	Very poor.
LaDelle-----	Good	Good	Good	---	Very poor.	Very poor	Good	Very poor.
84*:								
Wyndmere-----	Fair	Good	Good	Fair	Fair	Poor	Good	Poor.
Embden.								
86----- Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor.
87----- Marysland	Good	Good	Fair	Fair	Good	Good	Fair	Good.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife
89, 89B------------ Renshaw	Poor	Fair	Poor	---	Very poor.	Very poor	Poor	Very poor.
90B---------------- Arvilla	Fair	Good	Fair	Poor	Very poor.	Very poor	Fair	Very poor.
93----------------- Inkster	Fair	Good	Good	Fair	Poor	Poor	Good	Poor.
94*. Pits								
95----------------- Ojata	Poor	Poor	Very poor	Very poor.	Good	Good	Poor	Good.
96D*:								
Sioux-------------	Very poor	Very poor	Poor	---	Very poor.	Very poor	Very poor	Very poor.
Barnes------------	Fair	Good	Good	Fair	Very poor.	Very poor	Good	Very poor.
97D---------------- Sioux	Very poor	Very poor	Poor	---	Very poor.	Very poor	Very poor	Very poor.
98E*:								
Edgeley-----------	Fair	Good	Good	Fair	Very poor.	Very poor	Good	Very poor.
Kloten------------	Poor	Poor	Fair	Fair	Very poor.	Very poor	Poor	Very poor.
99*:								
Cavour------------	Poor	Poor	Poor	---	Very poor.	Very poor	Poor	Very poor.
Miranda-----------	Very poor	Very poor	Poor	---	Very poor.	Poor	Very poor	Very poor.
126---------------- Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
130B*:								
Svea--------------	Good	Good	Good	Good	Poor	Poor	Good	Poor.
Buse--------------	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor.
130C*:								
Buse--------------	Fair	Good	Fair	Fair	Very poor.	Very poor	Fair	Very poor.
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor.
148*:								
Wyndmere----------	Fair	Good	Good	Fair	Fair	Poor	Good	Poor.
Tiffany-----------	Fair	Fair	Good	Fair	Good	Fair	Fair	Fair.
171*:								
Antler------------	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
Tonka-------------	Good	Good	Fair	Poor	Good	Good	Good	Good.
173*:								
Glyndon-----------	Good	Good	Good	Fair	Poor	Poor	Good	Poor.
Tiffany-----------	Good	Good	Good	Fair	Good	Fair	Good	Fair.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife
199D---------------- Miranda Variant	Very poor	Very poor	Poor	Very poor.	Very poor.	Poor	Very poor	Very poor.
226*:								
Bearden------------	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
Perella------------	Good	Good	Good	Fair	Good	Good	Good	Good.
270----------------- Bearden	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair.
401*:								
Aberdeen-----------	Fair	Fair	Good	---	Very poor.	Poor	Fair	Very poor.
Nutley-------------	Good	Fair	Fair	---	Poor	Very poor	Fair	Very poor.
402*:								
Exline-------------	Very poor	Very poor	Very poor	---	Very poor.	Very poor	Very poor	Poor.
Aberdeen-----------	Fair	Fair	Good	---	Very poor.	Poor	Fair	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2: Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
3: Vallers	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: frost action, ponding.
4: Arveson	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: frost action, ponding.
8: Colvin	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
10: Lamoure	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods, frost action.
11: Dovray	Severe: ponding.	Severe: shrink-swell, ponding, low strength.	Severe: shrink-swell, ponding.	Severe: shrink-swell, ponding, low strength.	Severe: ponding, low strength, shrink-swell.
12: Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
13B: Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
15D*:					
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
15E*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
16: Lallie	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
17: Vang	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.
19: Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
23*:					
Cresbard	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Cavour	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
23B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Cresbard	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
25 Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
26*:					
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
29 Velva	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
30 Walsh	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
35 Rauville	Severe: cutbanks cave, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, wetness, floods.
39*:					
Vallers	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
Manfred	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
41*:					
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
42 Nutley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
43B---------------- Cashel	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: low strength, floods.
43E---------------- Cashel	Severe: wetness, slope.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, slope.	Severe: floods, wetness, shrink-swell.	Severe: low strength, slope, floods.
45----------------- Wahpeton	Moderate: too clayey, floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, floods, frost action.
46----------------- LaDelle	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods, frost action.
48----------------- Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
50B---------------- Hecla	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
51B*:					
Hecla-------------	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
Maddock-----------	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Slight.
51E---------------- Maddock	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
53----------------- Hamar	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
54B---------------- Embden	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
55----------------- Tiffany	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
59----------------- Towner	Severe: cutbanks cave.	Slight-----------	Moderate: wetness, shrink-swell.	Slight------------	Moderate: frost action.
60----------------- Grimstad	Moderate: cutbanks cave, wetness.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
62----------------- Rockwell	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: frost action, ponding.
64, 65------------- Antler	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
67----------------- Gilby	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
70*:					
Antler	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
71*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
72 Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
73 Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
76 Borup	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
78B*, 78C*:					
Zell	Slight	Slight	Slight	Moderate: slope.	Severe: low strength, frost action.
Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
79B*, 79C*:					
Zell	Slight	Slight	Slight	Moderate: slope.	Severe: low strength, frost action.
LaDelle	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
79D*:					
Zell	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.
LaDelle	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
84*:					
Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
86 Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: low strength, frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
87 Marysland	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: frost action, ponding.
89 Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
89B Renshaw	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
90B Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
93 Inkster	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
94*. Pits					
95 Ojata	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
96D*:					
Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
97D Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
98E*:					
Edgeley	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Kloten	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.
99*:					
Cavour	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Miranda	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
126 Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
130B*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
130C*:					
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
148*:					
Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Tiffany	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
171*:					
Antler	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
173*:					
Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
Tiffany	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
199D Miranda Variant	Moderate: depth to rock, too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
226*:					
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
270 Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
401*:					
Aberdeen	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Nutley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
402*:					
Exline	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
402*:					
Aberdeen----------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
3 Vallers	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
4 Arveson	Severe: ponding, poor filter.	Severe: ponding, seepage.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
8 Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
10 Lamoure	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: hard to pack, wetness.
11 Dovray	Severe: percs slowly, ponding.	Severe: ponding.	Severe: too clayey, ponding.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
12 Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
13B Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
15D*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
15E*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
16 Lallie	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
17: Vang	Severe: poor filter.	Severe: seepage.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage, small stones.
19: Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
23*:					
Cresbard	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
Cavour	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
23B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
25: Overly	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
26*:					
Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Overly	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Poor: thin layer.
29: Velva	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Good.
30: Walsh	Moderate: wetness, percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
35: Rauville	Severe: floods, wetness, percs slowly.	Severe: seepage, floods, wetness.	Severe: floods, seepage, wetness.	Severe: floods, wetness.	Poor: hard to pack, wetness.
39*:					
Vallers	Severe: ponding, percs slowly.	Severe: floods, ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
Manfred	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, excess sodium.	Severe: ponding.	Poor: hard to pack, ponding, excess sodium.
41*:					
Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
41*:					
Perella	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
42 Nutley	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
43B Cashel	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: too clayey, hard to pack.
43E Cashel	Severe: floods, wetness, percs slowly.	Severe: floods, slope, wetness.	Severe: floods, wetness, slope.	Severe: floods, wetness, slope.	Poor: too clayey, hard to pack, slope.
45 Wahpeton	Severe: floods, percs slowly.	Severe: floods.	Severe: floods, too clayey.	Severe: floods.	Poor: too clayey, hard to pack.
46 LaDelle	Severe: floods.	Severe: floods.	Severe: floods, wetness.	Severe: floods.	Poor: hard to pack.
48 Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
50B Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
51B*:					
Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
51E Maddock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
53 Hamar	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
54B Embden	Severe: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
55 Tiffany	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
59 Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
60 Grimstad	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
62 Rockwell	Severe: ponding.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
64 Antler	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
65 Antler	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
67 Gilby	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
70*:					
Antler	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
71*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
72 Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
73 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
76 Borup	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: wetness.
78B*:					
Zell	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Gardena	Moderate: wetness.	Moderate: seepage, slope, wetness.	Severe: wetness.	Moderate: wetness.	Good.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
78C*:					
Zell	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
Gardena	Moderate: wetness.	Moderate: seepage, slope, wetness.	Severe: wetness.	Moderate: wetness.	Good.
79B*:					
Zell	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
LaDelle	Moderate: wetness, percs slowly.	Moderate: seepage, slope, wetness.	Moderate: too clayey.	Slight	Poor: hard to pack.
79C*:					
Zell	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
LaDelle	Moderate: wetness, percs slowly.	Moderate: seepage, slope, wetness.	Moderate: too clayey.	Slight	Poor: hard to pack.
79D*:					
Zell	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
LaDelle	Moderate: wetness, percs slowly.	Moderate: seepage, slope, wetness.	Moderate: too clayey.	Slight	Poor: hard to pack.
84*:					
Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Embden	Severe: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
86 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
87 Marysland	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
89, 89B Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
90B Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
93------------------ Inkster	Severe: wetness, poor filter.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
94*. Pits					
95------------------ Ojata	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess salt.	Severe: wetness.	Poor: wetness, excess salt.
96D*: Sioux--------------	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Barnes-------------	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
97D----------------- Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
98E*: Edgeley------------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, hard to pack.
Kloten-------------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope.
99*: Cavour-------------	Severe: percs slowly.	Slight-----------	Severe: excess sodium.	Slight-----------	Poor: hard to pack, excess sodium.
Miranda------------	Severe: percs slowly.	Slight-----------	Severe: excess sodium.	Slight-----------	Poor: excess sodium.
126----------------- Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
130B*: Svea---------------	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Buse---------------	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
130C*: Buse---------------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Svea---------------	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
148*:					
Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Tiffany	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
171*:					
Antler	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
173*:					
Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
Tiffany	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
199D Miranda Variant	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
226*:					
Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Perella	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
270 Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
401*:					
Aberdeen	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.
Nutley	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
402*:					
Exline	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey, excess sodium.	Severe: wetness.	Poor: too clayey, hard to pack, excess sodium.
Aberdeen	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2 Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
3 Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
4 Arveson	Fair: wetness.	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
8 Colvin	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
10 Lamoure	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
11 Dovray	Poor: wetness, shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
12 Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
13B Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15D*:				
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
15E*:				
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
16 Lallie	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
17 Vang	Good	Probable	Probable	Poor: area reclaim, small stones.
19 Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
23*:				
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
23B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
25 Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
26*:				
Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
29 Velva	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
30 Walsh	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
35 Rauville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
39*:				
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Manfred	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.
41*:				
Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Perella	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
42 Nutley	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
43B Cashel	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
43E Cashel	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
45 Wahpeton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
46 LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
48 Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
50B Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
51B*:				
Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Maddock	Good	Probable	Improbable: too sandy.	Poor: thin layer.
51E Maddock	Fair: slope.	Probable	Improbable: too sandy.	Poor: thin layer, slope.
53 Hamar	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
54B Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
55 Tiffany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
59 Towner	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
60 Grimstad	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
62 Rockwell	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
64 Antler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
65 Antler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
67 Gilby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
70*:				
Antler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
71*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
72: Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
73: Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
76: Borup	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
78B*, 78C*:				
Zell	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
79B*, 79C*:				
Zell	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
79D*:				
Zell	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
84*:				
Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
86: Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
87: Marysland	Fair: wetness.	Probable	Probable	Fair: area reclaim, small stones, thin layer.
89, 89B: Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
90B: Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
93: Inkster	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
94*. Pits				
95: Ojata	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
96D*:				
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
96D*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
97D Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
98E*:				
Edgeley	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Kloten	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
99*:				
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
126 Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
130B*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
130C*:				
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
148*:				
Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Tiffany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
171*:				
Antler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
173*:				
Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Tiffany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
199D------------------ Miranda Variant	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
226*:				
Bearden--------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Perella--------------	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
270------------------- Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
401*:				
Aberdeen-------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Nutley---------------	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
402*:				
Exline---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
Aberdeen-------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
2 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
3 Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
4 Arveson	Severe: seepage.	Severe: seepage, piping, ponding.	Frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Ponding.
8 Colvin	Moderate: seepage.	Severe: ponding.	Percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Ponding, percs slowly.
10 Lamoure	Moderate: seepage.	Severe: hard to pack, wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
11 Dovray	Slight	Severe: hard to pack, ponding, excess humus.	Percs slowly, ponding.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
12 Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
13B Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope, excess salt.	Erodes easily	Erodes easily.
15D*, 15E*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
16 Lallie	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly, erodes easily.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
17 Vang	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
19 Hamerly	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
23*:						
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
23B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope, excess salt.	Erodes easily	Erodes easily.
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Favorable	Excess sodium, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
25: Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
26*:						
Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
29: Velva	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, floods.	Soil blowing	Favorable.
30: Walsh	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
35: Rauville	Moderate: seepage.	Severe: hard to pack, wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
39*:						
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
Manfred	Slight	Severe: ponding, excess sodium.	Ponding, percs slowly, frost action.	Ponding, percs slowly, excess sodium.	Ponding, percs slowly.	Wetness, excess sodium, percs slowly.
41*:						
Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Perella	Moderate: seepage.	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding	Wetness, percs slowly.
42: Nutley	Slight	Moderate: hard to pack.	Deep to water	Droughty, slow intake, percs slowly.	Percs slowly	Droughty, percs slowly.
43B: Cashel	Moderate: slope.	Severe: wetness.	Percs slowly, floods, slope.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
43E: Cashel	Severe: slope.	Severe: wetness.	Percs slowly, floods, slope.	Wetness, percs slowly.	Slope, wetness, percs slowly.	Wetness, slope, percs slowly.
45: Wahpeton	Moderate: seepage.	Severe: hard to pack.	Deep to water	Slow intake, floods.	Favorable	Favorable.
46: LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Floods	Favorable	Favorable.
48: Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
50B: Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
51B*:						
Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
51B*:						
Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
51E Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
53 Hamar	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
54B Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
55 Tiffany	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
59 Towner	Severe: seepage.	Severe: piping.	Deep to water	Droughty, soil blowing.	Erodes easily, soil blowing.	Erodes easily, droughty.
60 Grimstad	Severe: seepage.	Severe: piping.	Favorable	Wetness	Erodes easily, wetness, soil blowing.	Erodes easily.
62 Rockwell	Severe: seepage.	Moderate: ponding, piping.	Frost action	Ponding, soil blowing.	Ponding, soil blowing.	Ponding.
64 Antler	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
65 Antler	Severe: seepage.	Severe: wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
67 Gilby	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
70*:						
Antler	Severe: seepage.	Severe: wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
71*:						
Hamerly	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
72 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
73 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
76 Borup	Severe: seepage.	Severe: piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness	Wetness.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
78B*:						
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
78C*:						
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Gardena	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
79B*, 79C*:						
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Favorable	Favorable	Favorable.
79D*:						
Zell	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Favorable	Favorable	Favorable.
84*:						
Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
86 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
87 Marysland	Severe: seepage.	Severe: seepage, ponding.	Frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Ponding.
89 Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.
89B Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
90B Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
93 Inkster	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Too sandy, soil blowing.	Favorable.
94*. Pits						
95 Ojata	Slight	Severe: piping, wetness, excess salt.	Percs slowly, frost action, excess salt.	Wetness, droughty, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, excess salt, erodes easily.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
96D*:						
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope, excess salt.	Slope, erodes easily.	Slope, erodes easily.
97D Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
98E*:						
Edgeley	Severe: slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Kloten	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
99*:						
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
Miranda	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Percs slowly	Excess sodium, percs slowly.
126 Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
130B*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
130C*:						
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
148*:						
Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
Tiffany	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
171*:						
Antler	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
173*:						
Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
173*:						
Tiffany	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
199D Miranda Variant	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
226*:						
Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Perella	Moderate: seepage.	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding	Wetness, percs slowly.
270 Bearden	Moderate: seepage.	Severe: wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Excess salt.
401*:						
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Erodes easily	Excess sodium, erodes easily, percs slowly.
Nutley	Slight	Moderate: hard to pack.	Deep to water	Droughty, slow intake, percs slowly.	Percs slowly	Droughty, percs slowly.
402*:						
Exline	Slight	Severe: excess sodium.	Percs slowly, excess salt, excess sodium.	Slow intake, percs slowly, excess sodium.	Erodes easily, wetness, percs slowly.	Excess sodium, erodes easily, percs slowly.
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Erodes easily	Excess sodium, erodes easily, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
2---------------- Parnell	0-10	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	10-44	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	44-60	Clay loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
3---------------- Vallers	0-8	Loam-------------	OL, ML	A-4	0	95-100	90-100	80-90	50-80	30-40	4-10
	8-44	Clay loam, silty clay loam, sandy clay loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	44-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
4---------------- Arveson	0-11	Loam-------------	OL, ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
	11-41	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	41-60	Loamy sand, sandy loam, sand.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
8---------------- Colvin	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	11-21	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	21-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
10--------------- Lamoure	0-15	Silty clay loam	CL, CH, MH, ML	A-7	0	100	100	95-100	85-100	45-65	20-30
	15-41	Silty clay loam, silt loam.	CL, CH, MH, ML	A-7	0	100	100	90-100	85-100	40-65	15-30
	41-53	Silty clay loam, silt loam, loam.	CL, ML	A-6, A-7	0	95-100	95-100	90-100	75-100	30-50	10-20
	53-60	Stratified sandy loam to silty clay loam.	CL, SC	A-6, A-7	0	95-100	95-100	70-95	35-90	30-50	10-25
11--------------- Dovray	0-51	Clay-------------	CH, MH, OH	A-7	0	100	100	95-100	85-95	50-75	25-40
	51-60	Clay, silty clay loam, silt loam.	CH, MH, CL, ML	A-7	0	100	95-100	80-100	70-95	40-75	20-40
12--------------- Svea	0-17	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	17-31	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	31-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
13B-------------- Barnes	0-11	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-40	5-15
	11-22	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
	22-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
15D*:											
Buse------------	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	8-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
Svea------------	0-16	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	16-26	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	26-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
15E*:											
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
15E*:											
Svea	0-16	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	16-26	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	26-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
16 Lallie	0-4	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-95	35-50	15-30
	4-60	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	85-95	35-75	15-40
17 Vang	0-35	Loam, clay loam, sandy clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	80-100	55-80	25-45	5-15
	35-60	Sand, very shaly coarse sand.	SP-SM, SM, GM, GP-GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	---	NP
19 Hamerly	0-8	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	8-18	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
23*:											
Cresbard	0-10	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	10-22	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	22-60	Clay loam, silty clay, loam.	CL, CH	A-7, A-6	0	100	100	85-100	70-90	30-60	15-30
Cavour	0-12	Loam	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	12-27	Clay, clay loam, silty clay loam.	CLMCH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	27-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
23B*:											
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-40	5-15
	7-16	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
	16-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
Cresbard	0-8	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	8-24	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	24-60	Clay loam, silty clay, loam.	CL, CH	A-7, A-6	0	100	100	85-100	70-90	30-60	15-30
25 Overly	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-45	10-25
	12-48	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-95	25-50	5-30
	48-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-95	25-50	5-30
26*:											
Bearden	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-95	30-50	10-25
	10-21	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	21-60	Silt loam, silty clay loam, loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
Overly	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-45	10-25
	12-48	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-95	25-50	5-30
	48-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-95	25-50	5-30

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
29--------------- Velva	0-7	Sandy loam-------	ML, SM, CL-ML, SM-SC	A-4	0	100	100	60-95	35-65	15-25	NP-5
	7-60	Sandy loam, sand, fine sandy loam.	ML, SM	A-4	0	100	100	70-95	40-75	20-30	NP-5
30--------------- Walsh	0-18	Loam-------------	CL-ML, CL	A-4, A-6	0	95-100	85-100	80-100	60-95	25-40	5-20
	18-60	Loam, clay loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	95-100	85-100	80-100	60-95	25-50	5-30
35--------------- Rauville	0-30	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	90-100	80-100	35-50	10-25
	30-40	Silty clay loam, silt loam.	CL, CH, MH	A-6, A-7	0	100	100	90-100	85-100	35-60	15-20
	40-60	Stratified gravelly sand to clay loam.	SM, SC, CL, ML	A-2, A-4	0	80-100	65-95	50-85	15-70	<30	NP-10
39*:											
Vallers---------	0-14	Clay loam--------	OL, CL	A-6, A-7	0	95-100	95-100	95-100	85-95	30-50	10-20
	14-31	Clay loam--------	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	31-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
Manfred---------	0-8	Clay loam--------	CL, CH	A-6, A-7	0	100	100	90-100	70-95	35-55	15-30
	8-60	Loam, silty clay loam, clay loam.	CL, CH	A-6, A-7	0	100	100	85-100	50-95	25-55	10-35
41*:											
Bearden---------	0-9	Silty clay-------	CL, CH	A-7	0	100	100	95-100	90-95	40-60	20-40
	9-38	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	38-60	Silty clay, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
Perella---------	0-6	Silty clay-------	CL, CH	A-7	0	100	100	95-100	90-95	40-60	20-40
	6-20	Silt loam, silty clay loam, silty clay.	CL, CL-ML, CH	A-4, A-7, A-6	0	100	100	95-100	80-95	25-60	5-40
	20-60	Silt loam, silt, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-95	25-50	3-28
42--------------- Nutley	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
	8-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
43B, 43E--------- Cashel	0-9	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	45-70	20-40
	9-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	85-100	45-70	20-40
45--------------- Wahpeton	0-29	Silty clay-------	CH	A-7	0	100	100	95-100	80-95	50-75	25-50
	29-60	Clay, silty clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	80-95	35-75	25-50
46--------------- LaDelle	0-34	Silt loam--------	ML, CL	A-4, A-6, A-7	0	100	100	90-100	75-100	30-45	5-20
	34-60	Silt loam, silty clay loam, loam.	CL, ML, MH	A-6, A-7	0	100	100	90-100	75-100	30-55	10-25
48--------------- Wyndmere	0-10	Sandy loam-------	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	10-28	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	28-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
50B-------------- Hecla	0-17	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	60-85	30-50	15-30	NP-7
	17-37	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	37-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	95-100	85-100	10-35	15-30	NP-7
51B*:											
Hecla-----------	0-17	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	60-85	30-50	15-30	NP-7
	17-37	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	37-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	95-100	85-100	10-35	15-30	NP-7
Maddock---------	0-9	Fine sandy loam	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	9-60	Loamy sand, fine sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	60-95	5-35	---	NP
51E-------------- Maddock	0-14	Sandy loam-------	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	14-60	Loamy fine sand, fine sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	60-95	5-35	---	NP
53--------------- Hamar	0-11	Sandy loam-------	SM, SC, ML, CL	A-4	0	100	100	70-100	40-70	20-30	NP-10
	11-17	Loamy fine sand, loamy sand.	SM, SM-SC	A-2, A-4	0	100	100	85-100	15-40	<25	NP-5
	17-60	Fine sand, loamy sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	100	70-100	10-35	<25	NP-5
54B-------------- Embden	0-11	Fine sandy loam	SM, ML, SC	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	11-22	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	22-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
55--------------- Tiffany	0-9	Loam------------	ML, CL-ML, CL	A-4	0	100	100	85-95	50-80	15-35	NP-10
	9-60	Fine sandy loam, sandy clay loam, loamy fine sand, sandy loam.	SM, ML	A-2, A-4	0	100	100	50-95	20-55	---	NP
59--------------- Towner	0-12	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	100	60-85	30-45	<25	NP-5
	12-31	Loamy sand, loamy fine sand, fine sand.	SM	A-2	0	100	95-100	50-80	15-35	---	NP
	31-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	85-95	60-80	25-40	5-15
60--------------- Grimstad	0-21	Fine sandy loam	SM, SM-SC	A-4, A-2	0	100	100	80-100	15-50	15-30	NP-7
	21-37	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	90-100	80-90	5-35	<25	NP-4
	37-60	Fine sandy loam, loam, clay loam.	SC, CL, SM-SC, CL-ML	A-4, A-6	0-3	95-100	90-100	70-90	40-85	15-40	5-20

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
62----------------- Rockwell	0-9	Fine sandy loam	ML, SM, SM-SC, CL-ML	A-4	0	100	95-100	70-85	40-55	15-25	1-7
	9-16	Fine sandy loam, sandy loam, loam.	SM, ML, SM-SC, CL-ML	A-4	0	100	95-100	60-85	35-55	15-25	1-7
	16-24	Fine sand, sand, loamy fine sand.	SM	A-2	0	100	95-100	65-80	20-35	---	NP
	24-60	Silt loam, loam, clay loam.	CL, CL-ML, SC, SM-SC	A-6, A-4	0-1	95-100	90-100	70-90	40-85	15-40	5-20
64----------------- Antler	0-9	Silt loam---------	ML, CL	A-4, A-6	0	95-100	95-100	90-100	70-90	30-40	5-15
	9-29	Clay loam, silty clay loam, silt loam.	ML, CL	A-7, A-6	0-5	95-100	95-100	90-100	70-95	35-50	10-25
	29-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-100	60-80	20-50	10-25
65----------------- Antler	0-8	Silty clay loam	CL, ML	A-6, A-7	0	95-100	95-100	90-100	70-90	35-50	10-25
	8-18	Silty clay loam	CL, ML	A-6, A-7	0	95-100	95-100	90-100	70-90	35-50	10-25
	18-23	Stratified fine sandy loam.	SM, SM-SC	A-2, A-4	3-15	95-100	95-100	60-85	30-50	<30	NP-10
	23-60	Clay loam---------	CL, ML	A-6, A-7	0-5	95-100	95-100	90-100	70-90	35-50	10-25
67----------------- Gilby	0-12	Loam--------------	CL-ML, CL, ML	A-4	0-5	95-100	90-100	80-95	60-85	20-35	5-10
	12-26	Loam, silt loam, very fine sandy loam.	CL-ML, CL, ML	A-4	0-5	95-100	90-100	80-95	50-85	20-35	5-10
	26-60	Loam, clay loam	CL	A-6, A-7	0-10	95-100	90-100	80-95	65-80	25-50	10-25
70*:											
Antler-----------	0-7	Silty clay loam	CL, ML	A-6, A-7	0	95-100	95-100	90-100	70-90	35-50	10-25
	7-36	Silty clay loam	CL, ML	A-6, A-7	0	95-100	95-100	90-100	70-90	35-50	10-25
	36-60	Clay loam---------	CL, ML	A-6, A-7	0-5	95-100	95-100	90-100	70-90	35-50	10-25
Tonka------------	0-19	Silty clay loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	19-34	Silty clay loam, silty clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
71*:											
Hamerly----------	0-8	Loam--------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	8-18	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
Tonka------------	0-18	Silt loam---------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	18-32	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	32-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
72----------------- Gardena	0-14	Silt loam---------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
	14-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
73----------------- Glyndon	0-10	Silt loam---------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	10-22	Silt loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	22-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
76---------------- Borup	0-12	Silt loam---------	OL, ML	A-4	0	100	100	95-100	70-95	20-34	NP-7
	12-34	Very fine sandy loam, loamy very fine sand, silt loam.	ML	A-4	0	100	100	90-100	60-95	<30	NP-5
	34-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML	A-4	0	100	100	85-100	50-90	<30	NP-5
78B*, 78C*:											
Zell-------------	0-9	Silt loam---------	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	9-60	Silt loam, very fine sandy loam, loam.	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
Gardena----------	0-17	Silt loam---------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
	17-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
79B*, 79C*, 79D*:											
Zell-------------	0-10	Silt loam---------	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	10-60	Silt loam, very fine sandy loam, silty clay loam.	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
LaDelle----------	0-34	Silt loam---------	ML, CL	A-4, A-6, A-7	0	100	100	90-100	75-100	30-45	5-20
	34-60	Silt loam, silty clay loam, loam.	CL, ML, MH, CH	A-6, A-7	0	100	100	90-100	75-100	30-55	10-25
84*:											
Wyndmere---------	0-10	Sandy loam--------	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	10-28	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	28-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
Embden-----------	0-10	Sandy loam--------	SM, ML, SC	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	10-23	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	23-60	Sandy loam, loamy fine sand, fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
86---------------- Divide	0-10	Loam--------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	10-25	Loam, gravelly clay loam.	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	20-40	5-20
	25-60	Stratified fine sand to gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
87---------------- Marysland	0-16	Loam--------------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	16-33	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	33-60	Stratified sand to very gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
89, 89B---------- Renshaw	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	8-15	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-37	3-15
	15-60	Sand and gravel	SW, SM, GW, GW-GM	A-1	0-5	45-95	40-70	10-50	0-15	<25	NP-5
90B-------------- Arvilla	0-18	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
	18-60	Gravelly coarse sand, coarse sand, sand.	SP-SM, GP, SP, GP-GM	A-1	0	35-95	25-90	10-50	0-10	---	NP
93--------------- Inkster	0-6	Sandy loam-------	SM-SC, SC, SM	A-4, A-2, A-6	0	100	100	60-70	30-40	<25	3-15
	6-24	Sandy loam, fine sandy loam.	SM, SM-SC, SC	A-4, A-2, A-6	0	100	100	60-75	30-45	<30	3-15
	24-37	Sandy loam, loamy sand.	SM, SM-SC, SC	A-4, A-2, A-6	0	100	100	50-70	15-40	<30	3-15
	37-60	Sandy loam, loamy sand.	SM, SM-SC, SC	A-4, A-2, A-6	0	100	100	50-70	15-40	<30	3-15
94*. Pits											
95--------------- Ojata	0-8	Silty clay loam	CL-ML, CL	A-4, A-6, A-7	0	100	100	90-100	80-95	20-50	5-25
	8-60	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	95-100	85-95	20-50	5-25
96D*: Sioux-----------	0-6	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	6-11	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, SM-SC	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	11-60	Sand and gravel	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
Barnes----------	0-11	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-40	5-15
	11-22	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
	22-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
97D-------------- Sioux	0-7	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	7-10	Gravelly loam, very gravelly sandy loam, gravelly loamy sand.	SM, SM-SC	A-4, A-2, A-1	0-5	60-90	45-80	45-70	15-50	20-35	NP-7
	10-60	Sand and gravel	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
98E*: Edgeley---------	0-6	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	85-95	60-75	20-40	5-25
	6-36	Clay loam, shaly clay loam, silt loam.	CL, CH	A-6, A-7	0-5	80-100	75-100	65-95	55-95	25-55	10-40
	36-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Kloten----------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-10	90-100	90-100	85-95	60-80	20-40	5-20
	9-60	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
99*:											
Cavour----------	0-12	Loam-------------	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	12-27	Clay, clay loam, silty clay loam.	CLMCH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	27-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
Miranda---------	0-3	Loam-------------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	3-12	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	60-80	30-50	10-20
	12-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	60-80	30-50	10-20
126------------- Bearden	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-95	30-50	10-25
	10-21	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	21-60	Silt loam, silty clay loam, loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
130B*:											
Svea------------	0-17	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	17-31	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	31-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
Buse------------	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	8-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
130C*:											
Buse------------	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	8-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
Svea------------	0-17	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	17-31	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	31-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
148*:											
Wyndmere--------	0-8	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	8-33	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	33-60	Fine sand, loamy fine sand, loamy very fine sand.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
Tiffany---------	0-15	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-2, A-4	0	100	100	60-85	30-55	<30	NP-10
	15-60	Fine sandy loam, loamy fine sand, loamy very fine sand.	SM, ML	A-2, A-4	0	100	100	50-95	20-55	---	NP
171*:											
Antler----------	0-9	Silt loam--------	ML, CL	A-4, A-6	0	95-100	95-100	90-100	70-90	30-40	5-15
	9-29	Clay loam, silty clay loam, silt loam.	ML, CL	A-7, A-6	0-5	95-100	95-100	90-100	70-95	35-50	10-25
	29-60	Loam, clay loam, silt loam.	CL, ML	A-6, A-7	0-5	95-100	95-100	85-100	60-80	20-50	10-25

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
171*:											
Tonka	0-19	Silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	19-34	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
173*:											
Glyndon	0-13	Silt loam	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	13-40	Silt loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	40-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10
Tiffany	0-60	Silt loam	ML, CL-ML, CL	A-4	0	100	100	85-95	50-80	15-35	NP-10
199D Miranda Variant	0-4	Loam	CL	A-6, A-7	0	100	100	85-95	60-75	30-45	10-25
	4-25	Clay	CH	A-7	0	100	100	95-100	85-95	50-75	30-45
	25-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
226*:											
Bearden	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-95	30-50	10-25
	8-23	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	23-60	Silt loam, silty clay loam, loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
Perella	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	25-50	10-30
	11-24	Silt loam, silty clay loam, silty clay.	CL, CL-ML, CH	A-4, A-7, A-6	0	100	100	95-100	80-95	25-60	5-40
	24-60	Silt loam, silt, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-95	25-50	3-28
270 Bearden	0-13	Silty clay loam	ML, CL	A-6, A-7, A-4	0	100	100	95-100	80-95	30-50	7-27
	13-18	Silt loam, silty clay loam.	ML, CL	A-6, A-7, A-4	0	100	100	95-100	80-95	30-50	7-27
	18-60	Silt loam, silty clay loam, loam.	ML, CL	A-6, A-7, A-4	0	100	100	95-100	80-95	30-50	7-27
401*:											
Aberdeen	0-8	Silty clay	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	8-60	Silty clay, clay, silty clay loam.	CH, ML, CL	A-7	0	100	100	95-100	90-100	45-75	15-40
Nutley	0-9	Silty clay	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
	9-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
402*:											
Exline	0-8	Silty clay	CH, MH	A-7	0	100	100	95-100	90-100	50-75	25-40
	8-26	Clay, silty clay, silty clay loam.	MH, CH	A-7	0	100	100	95-100	90-100	60-90	30-50
	26-40	Silty clay loam, silty clay, clay.	CH, MH	A-7	0	100	100	95-100	85-100	50-80	20-45
	40-60	Stratified silt to clay.	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
Aberdeen	0-8	Silty clay	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	8-60	Silty clay, clay, silty clay loam.	CH, ML, CL	A-7	0	100	100	95-100	90-100	45-75	15-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
2----------------	0-10	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low--------	0.28	5	6
Parnell	10-44	0.06-0.2	0.13-0.19	6.6-7.8	<2	High-------	0.28		
	44-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
3----------------	0-8	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low--------	0.28	5	4L
Vallers	8-44	0.2-0.6	0.15-0.19	7.9-8.4	<4	Moderate	0.28		
	44-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28		
4----------------	0-11	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low--------	0.24	4	4L
Arveson	11-41	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low--------	0.24		
	41-60	2.0-20	0.05-0.15	7.4-8.4	<2	Low--------	0.17		
8----------------	0-11	0.2-0.6	0.20-0.22	7.4-9.0	<2	High-------	0.32	5	4L
Colvin	11-21	0.06-2.0	0.16-0.20	7.4-9.0	<2	High-------	0.32		
	21-60	0.06-2.0	0.15-0.20	7.4-9.0	<2	High-------	0.32		
10---------------	0-15	0.6-2.0	0.19-0.22	7.4-8.4	<4	Moderate	0.28	5	4L
Lamoure	15-41	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	41-53	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	53-60	0.6-2.0	0.09-0.18	7.4-8.4	<4	Low--------	0.28		
11---------------	0-51	0.06-0.6	0.13-0.16	6.1-7.8	<2	High-------	0.28	5	4
Dovray	51-60	<0.6	0.10-0.18	6.6-8.4	<2	High-------	0.28		
12---------------	0-17	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
Svea	17-31	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	31-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
13B--------------	0-11	0.6-2.0	0.13-0.24	6.6-7.8	<2	Low--------	0.28	5	6
Barnes	11-22	0.6-2.0	0.15-0.19	6.6-7.8	<4	Moderate	0.28		
	22-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
15D*:									
Buse-------------	0-8	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	8-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea-------------	0-16	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	16-26	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	26-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
15E*:									
Buse-------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea-------------	0-16	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	16-26	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	26-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
16---------------	0-4	0.06-0.2	0.12-0.15	7.4-9.0	4-16	Moderate	0.37	5	8
Lallie	4-60	0.06-0.2	0.10-0.15	7.4-9.0	4-16	High-------	0.37		
17---------------	0-35	0.6-2.0	0.17-0.21	6.6-8.4	<2	Low--------	0.28	4	6
Vang	35-60	>6.0	0.02-0.04	6.6-8.4	<2	Low--------	0.10		
19---------------	0-8	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
Hamerly	8-18	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	18-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
23*:									
Cresbard---------	0-10	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	10-22	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High-------	0.32		
	22-60	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High-------	0.32		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
23*:									
Cavour----------	0-12	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	12-27	<0.2	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	27-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
23B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	7-16	0.6-2.0	0.15-0.19	6.6-7.8	<4	Moderate	0.28		
	16-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Cresbard--------	0-8	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	8-24	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High------	0.32		
	24-60	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High------	0.32		
25--------------- Overly	0-12	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	12-48	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	0.32		
	48-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
26*:									
Bearden---------	0-10	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	10-21	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28		
	21-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
Overly----------	0-12	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	12-48	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	0.32		
	48-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
29--------------- Velva	0-7	0.6-6.0	0.13-0.22	6.6-7.3	<2	Low-------	0.20	5	3
	7-60	0.6-6.0	0.16-0.22	7.4-8.4	<2	Low-------	0.20		
30--------------- Walsh	0-18	0.6-2.0	0.20-0.24	6.6-7.3	<2	Moderate	0.28	5	6
	18-60	0.6-2.0	0.14-0.22	6.6-8.4	<2	Moderate	0.43		
35--------------- Rauville	0-30	0.6-2.0	0.19-0.22	7.4-8.4	<2	Moderate	0.28	5	4L
	30-40	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	40-60	2.0-6.0	0.08-0.15	7.4-8.4	<4	Low-------	0.10		
39*:									
Vallers---------	0-14	0.2-0.6	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	14-31	0.2-0.6	0.10-0.13	7.9-8.4	4-16	Low-------	0.28		
	31-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low-------	0.28		
Manfred---------	0-8	0.06-0.2	0.17-0.23	7.9-9.0	2-4	High------	0.32	3	7
	8-60	0.06-0.2	0.17-0.23	7.9-9.0	2-16	High------	0.32		
41*:									
Bearden---------	0-9	0.06-0.2	0.15-0.18	7.4-8.4	<4	Moderate	0.28	5	4L
	9-38	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28		
	38-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
Perella---------	0-6	0.06-0.2	0.15-0.18	6.6-7.8	<2	Moderate	0.28	5	4
	6-20	0.06-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
	20-60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28		
42--------------- Nutley	0-8	0.06-0.2	0.10-0.16	7.4-8.4	<2	High------	0.28	5	4
	8-60	<0.2	0.08-0.15	7.4-8.4	<2	High------	0.28		
43B, 43E--------- Cashel	0-9	0.2-0.6	0.18-0.23	7.4-8.4	<2	High------	0.32	5	7
	9-60	0.06-0.6	0.13-0.17	7.4-8.4	<2	High------	0.32		
45--------------- Wahpeton	0-29	0.2-2.0	0.14-0.18	6.1-7.8	<2	High------	0.28	5	4
	29-60	0.2-2.0	0.13-0.17	7.4-7.8	<2	High------	0.28		
46--------------- LaDelle	0-34	0.6-2.0	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	6
	34-60	0.6-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.28		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
48----------------- Wyndmere	0-10	2.0-6.0	0.13-0.18	7.9-8.4	<2	Low--------	0.20	5	3
	10-28	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low--------	0.20		
	28-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20		
50B---------------- Hecla	0-17	2.0-6.0	0.14-0.17	6.1-7.8	<2	Low--------	0.17	5	3
	17-37	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17		
	37-60	2.0-20	0.06-0.13	6.1-8.4	<2	Low--------	0.17		
51B*:									
Hecla------------	0-17	2.0-6.0	0.14-0.17	6.1-7.8	<2	Low--------	0.17	5	3
	17-37	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17		
	37-60	2.0-20	0.06-0.13	6.1-8.4	<2	Low--------	0.17		
Maddock----------	0-9	6.0-20	0.13-0.18	6.6-7.8	<2	Low--------	0.17	5	3
	9-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
51E---------------- Maddock	0-14	6.0-20	0.13-0.18	6.6-7.8	<2	Low--------	0.17	5	3
	14-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
53----------------- Hamar	0-11	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low--------	0.17	5	3
	11-16	2.0-20	0.10-0.12	6.6-8.4	<2	Low--------	0.17		
	16-60	2.0-20	0.6-0.8	7.4-8.4	<2	Low--------	0.17		
54B---------------- Embden	0-11	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low--------	0.20	5	3
	11-22	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low--------	0.20		
	22-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20		
55----------------- Tiffany	0-9	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.28	5	5
	9-60	0.6-6.0	0.10-0.17	6.6-7.8	<2	Low--------	0.20		
59----------------- Towner	0-12	2.0-6.0	0.13-0.18	6.6-7.8	<2	Low--------	0.20	5	3
	12-31	6.0-20	0.06-0.13	6.6-7.8	<2	Low--------	0.20		
	31-60	0.2-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
60----------------- Grimstad	0-21	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low--------	0.20	5	3
	21-37	6.0-20	0.08-0.14	7.4-9.0	<2	Low--------	0.20		
	37-60	0.6-2.0	0.11-0.19	7.4-9.0	<2	Low--------	0.37		
62----------------- Rockwell	0-9	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low--------	0.24	5	3
	9-16	2.0-6.0	0.15-0.17	7.9-8.4	<2	Low--------	0.24		
	16-24	6.0-20	0.05-0.07	7.4-7.8	<2	Low--------	0.24		
	24-60	0.6-2.0	0.18-0.22	7.4-7.8	<2	Low--------	0.24		
64----------------- Antler	0-9	0.2-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.28	5	4L
	9-29	0.2-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.37		
	29-60	0.06-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
65----------------- Antler	0-8	0.6-2.0	0.10-0.15	7.4-7.8	4-16	Moderate	0.28	5	4L
	8-18	0.2-0.6	0.10-0.15	7.9-8.4	4-16	Moderate	0.28		
	18-23	2.0-6.0	0.13-0.16	7.9-8.4	4-16	Low--------	0.17		
	23-60	0.2-0.6	0.10-0.15	7.4-7.8	4-16	Moderate	0.28		
67----------------- Gilby	0-12	0.6-2.0	0.17-0.24	7.4-8.4	<2	Low--------	0.28	5	4L
	12-26	0.6-2.0	0.17-0.22	7.9-8.4	<2	Low--------	0.28		
	26-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate	0.37		
70*:									
Antler-----------	0-7	0.6-2.0	0.10-0.15	7.4-7.8	4-16	Moderate	0.28	5	4L
	7-36	0.2-0.6	0.10-0.15	7.9-8.4	4-16	Moderate	0.28		
	36-60	0.2-0.6	0.10-0.15	7.4-7.8	4-16	Moderate	0.28		
Tonka------------	0-19	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low--------	0.32	5	6
	19-34	0.06-0.2	0.14-0.19	5.6-7.3	<2	High-------	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
71*:									
Hamerly----------	0-8	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	8-18	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	18-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka------------	0-18	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low--------	0.32	5	6
	18-32	0.06-0.2	0.14-0.19	5.6-7.3	<2	High-------	0.43		
	32-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
72--------------- Gardena	0-14	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	14-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
73--------------- Glyndon	0-10	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	4	4L
	10-22	0.6-6.0	0.17-0.20	7.9-9.0	<4	Low--------	0.28		
	22-60	2.0-20	0.15-0.19	7.9-8.4	<4	Low--------	0.28		
76--------------- Borup	0-12	2.0-6.0	0.20-0.23	7.4-8.4	<4	Low--------	0.28	5	4L
	12-34	2.0-6.0	0.17-0.20	7.4-8.4	<4	Low--------	0.28		
	34-60	2.0-20	0.15-0.19	7.9-8.4	2-8	Low--------	0.28		
78B*, 78C*:									
Zell-------------	0-9	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L
	9-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
Gardena----------	0-17	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	17-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
79B*, 79C*, 79D*:									
Zell-------------	0-10	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L
	10-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
LaDelle----------	0-34	0.6-2.0	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	6
	34-60	0.6-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.28		
84*:									
Wyndmere---------	0-10	2.0-6.0	0.13-0.18	7.9-8.4	<2	Low--------	0.20	5	3
	10-28	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low--------	0.20		
	28-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20		
Embden-----------	0-10	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low--------	0.20	5	3
	10-23	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low--------	0.20		
	23-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20		
86--------------- Divide	0-10	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28	4	4L
	10-25	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low--------	0.28		
	25-60	>6.0	0.03-0.07	7.9-8.4	<2	Low--------	0.10		
87--------------- Marysland	0-16	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
	16-33	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	33-60	>6.0	0.02-0.07	7.9-8.4	<2	Low--------	0.15		
89, 89B---------- Renshaw	0-8	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low--------	0.28	3	6
	8-15	2.0-6.0	0.11-0.18	6.6-7.8	<2	Low--------	0.28		
	15-60	>20	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
90B-------------- Arvilla	0-18	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low--------	0.20	3	3
	18-60	>6.0	0.02-0.05	7.4-8.4	<2	Low--------	0.10		
93--------------- Inkster	0-6	2.0-6.0	0.13-0.15	5.6-7.3	<2	Low--------	0.20	3	3
	6-24	2.0-6.0	0.12-0.14	5.6-7.3	<2	Low--------	0.20		
	24-37	2.0-20	0.08-0.13	5.6-7.8	<2	Low--------	0.20		
	37-60	2.0-20	0.08-0.13	5.6-7.8	<2	Low--------	0.20		
94*. Pits									
95--------------- Ojata	0-8	0.06-0.6	0.03-0.05	7.4-9.0	>16	Moderate	0.32	5	7
	8-60	0.06-0.6	0.07-0.10	7.4-9.0	>8	Moderate	0.43		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
96D*:									
Sioux-----------	0-6	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	8
	6-11	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	11-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
Barnes-----------	0-11	0.6-2.0	0.13-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	11-22	0.6-2.0	0.15-0.19	6.6-7.8	<4	Moderate	0.28		
	22-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
97D--------------- Sioux	0-7	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	8
	7-10	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	10-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
98E*:									
Edgeley----------	0-6	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low--------	0.28	4	6
	6-36	0.6-2.0	0.13-0.19	6.6-7.8	<2	Moderate	0.28		
	36-60	---	---	---	---	-----------	----		
Kloten-----------	0-9	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.32	2	6
	9-60	---	---	---	---	-----------	----		
99*:									
Cavour-----------	0-12	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	12-27	<0.2	0.10-0.16	6.6-9.0	4-16	High-------	0.37		
	27-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
Miranda----------	0-3	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.32	1	6
	3-12	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	12-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
126-------------- Bearden	0-10	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	10-21	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28		
	21-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
130B*:									
Svea-------------	0-17	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	17-31	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	31-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse-------------	0-8	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	8-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
130C*:									
Buse-------------	0-8	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	8-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea-------------	0-17	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	17-31	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	31-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
148*:									
Wyndmere---------	0-8	2.0-6.0	0.13-0.18	7.9-8.4	<2	Low--------	0.20	5	3
	8-33	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low--------	0.20		
	33-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20		
Tiffany----------	0-15	0.6-2.0	0.13-0.18	6.1-7.8	<2	Low--------	0.20	5	3
	15-60	0.6-6.0	0.10-0.17	6.6-7.8	<2	Low--------	0.20		
171*:									
Antler-----------	0-9	0.2-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.28	5	4L
	9-29	0.2-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.37		
	29-60	0.06-0.6	0.14-0.19	7.9-8.4	<2	Moderate	0.37		
Tonka------------	0-19	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low--------	0.32	5	6
	19-34	0.06-0.2	0.14-0.19	5.6-7.3	<2	High-------	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
173*:									
Glyndon----------	0-13	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	4	4L
	13-40	0.6-6.0	0.17-0.20	7.9-9.0	<4	Low--------	0.28		
	40-60	2.0-20	0.15-0.19	7.9-8.4	<4	Low--------	0.28		
Tiffany----------	0-60	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.28	5	5
199D-------------- Miranda Variant	0-4	0.6-2.0	0.18-0.22	5.6-7.3	<2	Moderate	0.24	1	6
	4-25	<0.06	0.10-0.15	6.1-8.4	4-16	High-------	0.32		
	25-60	---	---	---	---	-----------	----		
226*:									
Bearden----------	0-8	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	8-23	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28		
	23-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
Perella----------	0-11	0.2-2.0	0.18-0.23	6.6-7.8	<2	Moderate	0.28	5	7
	11-24	0.06-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
	24-60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28		
270--------------- Bearden	0-13	0.6-2.0	0.14-0.16	7.4-7.8	4-16	Moderate	0.32	5	4L
	13-18	0.2-2.0	0.14-0.16	7.9-8.4	4-16	Moderate	0.32		
	18-60	0.2-2.0	0.11-0.13	7.9-8.4	4-16	Moderate	0.32		
401*:									
Aberdeen---------	0-8	0.06-0.2	0.19-0.22	5.6-7.3	<2	High-------	0.32	3	7
	8-60	0.06-0.2	0.13-0.18	7.4-9.0	<4	High-------	0.32		
Nutley-----------	0-9	0.06-0.2	0.10-0.16	7.4-8.4	<2	High-------	0.28	5	4
	9-60	<0.2	0.08-0.15	7.4-8.4	<2	High-------	0.28		
402*:									
Exline-----------	0-8	0.2-0.6	0.10-0.15	6.1-7.3	<4	High-------	0.28	3	4
	8-26	<0.06	0.10-0.15	6.6-9.0	4-16	High-------	0.28		
	26-40	0.06-0.2	0.14-0.17	7.9-9.0	4-8	High-------	0.43		
	40-60	0.06-0.2	0.14-0.17	7.9-9.0	2-8	Moderate	0.43		
Aberdeen---------	0-8	0.06-0.2	0.19-0.22	5.6-7.3	<2	High-------	0.32	3	7
	8-60	0.06-0.2	0.13-0.18	7.4-9.0	<4	High-------	0.32		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
2*: Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
3*: Vallers	C	None	---	---	+.5-2.5	Apparent	Nov-Jun	High	High	Low.
4*: Arveson	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
8*: Colvin	C/D	None	---	---	+1-1.0	Apparent	Apr-Jul	High	High	Low.
10: Lamoure	C	Frequent	Brief	Mar-Oct	0-2.0	Apparent	Oct-Jun	High	High	Moderate.
11*: Dovray	C/D	None	---	---	+2-1.0	Apparent	Jan-Dec	Moderate	High	Low.
12: Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
13B: Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
15D, 15E:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
16*: Lallie	D	None	---	---	+1-1.0	Apparent	Apr-Mar	High	High	High.
17: Vang	B	None	---	---	>6.0	---	---	Moderate	High	Low.
19: Hamerly	C	None	---	---	1.5-3.0	Apparent	Sep-Jun	High	High	Low.
23:										
Cresbard	C	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Cavour	D	None	---	---	>6.0	---	---	Moderate	High	Moderate.
23B:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Cresbard	C	None	---	---	>6.0	---	---	Moderate	High	Moderate.
25: Overly	C	None	---	---	>6.0	---	---	High	High	Low.
26:										
Bearden	C	None	---	---	1.5-2.5	Apparent	Sep-Jun	High	High	Low.
Overly	C	None	---	---	>6.0	---	---	High	High	Low.
29: Velva	B	Occasional	Very brief to brief.	Mar-Jun	>6.0	---	---	Moderate	High	Low.
30: Walsh	B	None	---	---	4.0-6.0	Apparent	Mar-Jun	Moderate	High	Low.
35: Rauville	D	Frequent	Brief	Mar-Oct	0-2.0	Apparent	Jan-Dec	High	High	Moderate.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
39*:										
Vallers	C	None	---	---	+.5-1.0	Apparent	Apr-Jul	High	High	Moderate.
Manfred	D	None	---	---	+1-1.0	Apparent	Mar-Aug	High	High	Low.
41:										
Bearden	C	None	---	---	1.5-2.5	Apparent	Sep-Jun	High	High	Low.
Perella*	B/D	None	---	---	+1-1.0	Apparent	Apr-Jul	High	High	Low.
42 Nutley	C	None	---	---	>6.0	---	---	Moderate	High	Low.
43B, 43E Cashel	C	Occasional	Brief	Mar-May	1.0-3.0	Apparent	Apr-Jul	Moderate	High	Low.
45 Wahpeton	C	Occasional	Brief	Mar-Jun	>6.0	---	---	High	High	Low.
46 LaDelle	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Oct-Jun	High	High	Low.
48 Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	High	High	Low.
50B Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
51B:										
Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
51E Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
53 Hamar	A/D	None	---	---	0-2.0	Apparent	Oct-Jun	Moderate	High	Low.
54B Embden	B	None	---	---	3.5-6.0	Apparent	Apr-Jun	Moderate	High	Low.
55* Tiffany	B/D	None	---	---	+1-3.0	Apparent	Apr-Jun	High	High	Low.
59 Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
60 Grimstad	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Moderate	Low.
62* Rockwell	B/D	None	---	---	+1-3.0	Apparent	Apr-Jul	High	High	Low.
64, 65 Antler	C	None	---	---	1.0-4.0	Apparent	Apr-Jun	High	High	Low.
67 Gilby	B	None	---	---	1.0-4.0	Apparent	Apr-Jun	High	High	Low.
70:										
Antler	C	None	---	---	1.0-4.0	Apparent	Apr-Jun	High	High	Low.
Tonka*	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
71:										
Hamerly	C	None	---	---	1.5-3.0	Apparent	Sep-Jun	High	High	Low.
Tonka*	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
72----------------- Gardena	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	Moderate	Low.
73----------------- Glyndon	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Low.
76----------------- Borup	B/D	None---------	---	---	1.0-2.5	Apparent	Apr-Jul	High-----	High-----	Low.
78B, 78C:										
Zell--------------	B	None---------	---	---	>6.0	---	---	High-----	High-----	Moderate.
Gardena-----------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	Moderate	Low.
79B, 79C, 79D:										
Zell--------------	B	None---------	---	---	>6.0	---	---	High-----	High-----	Moderate.
LaDelle-----------	B	None---------	---	---	4.0-6.0	Perched	Apr-Jun	High-----	High-----	Low.
84:										
Wyndmere----------	B	None---------	---	---	2.0-5.0	Apparent	Sep-Jun	High-----	High-----	Low.
Embden------------	B	None---------	---	---	3.5-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
86----------------- Divide	B	None---------	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High-----	Low.
87*---------------- Marysland	B/D	None---------	---	---	+1-2.5	Apparent	Nov-Jul	High-----	High-----	Low.
89, 89B------------ Renshaw	B	None---------	---	---	>2 .0	---	---	Low------	Moderate	Low.
90B---------------- Arvilla	A	None---------	---	---	>6.0	---	---	Low------	Moderate	Low.
93----------------- Inkster	B	None---------	---	---	3.5-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
94. Pits										
95----------------- Ojata	D	None---------	---	---	0-1.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
96D:										
Sioux-------------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Low.
Barnes------------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
97D---------------- Sioux	A	None---------	---	---	>6.0	---	---	Low------	Low------	Low.
98E:										
Edgeley-----------	C	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Kloten------------	D	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
99:										
Cavour------------	D	None---------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
Miranda-----------	D	None---------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
126---------------- Bearden	C	None---------	---	---	1.5-2.5	Apparent	Sep-Jun	High-----	High-----	Low.
130B:										
Svea--------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
130B:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
130C:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
148:										
Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	High	High	Low.
Tiffany*	B/D	None	---	---	+1-3.0	Apparent	Apr-Jun	High	High	Low.
171:										
Antler	C	None	---	---	1.0-4.0	Apparent	Apr-Jun	High	High	Low.
Tonka*	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
173:										
Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	High	High	Low.
Tiffany*	B/D	None	---	---	+1-3.0	Apparent	Apr-Jun	High	High	Low.
199D Miranda Variant	D	None	---	---	>6.0	---	---	Moderate	High	Moderate.
226:										
Bearden	C	None	---	---	1.5-2.5	Apparent	Sep-Jun	High	High	Low.
Perella*	B/D	None	---	---	+1-1.0	Apparent	Apr-Jul	High	High	Low.
270 Bearden	C	None	---	---	1.5-2.5	Apparent	Sep-Jun	High	High	Moderate.
401:										
Aberdeen	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Nutley	C	None	---	---	>6.0	---	---	Moderate	High	Low.
402:										
Exline	D	None	---	---	2.5-4.0	Apparent	Apr-Jun	Moderate	High	High.
Aberdeen	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.

* In the "High water table--Depth" column, a plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

TABLE 16.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available. NP means nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution									Liquid limit	Plasticity index	Moisture density		Shrinkage		
			Percentage passing sieve--						Percentage smaller than--									
	AASHTO	Unified	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Maximum density	Optimum moisture	Limit	Linear	Ratio
												Pct		Lb/ Ft3	Pct	Pct	Pct	Pct
Antler silt loam: (S77ND-035-025)																		
IIC3-----29 to 40	A-6(09)	CL	100	100	97	96	88	67	--	26	--	34	17	122	12	14.0	0.0	1.9
IIC4-----40 to 60	A-6(06)	CL	100	99	96	94	86	64	--	23	--	32	13	121	12	16.0	0.0	1.8
Barnes loam: (S77ND-035-013)																		
B2-------11 to 22	A-6(06)	CL	100	98	95	93	83	54	--	25	--	35	17	120	13	14.0	0.0	1.8
C2-------29 to 60	A-6(07)	CL	100	97	95	93	85	61	--	25	--	35	15	112	15	16.0	0.0	1.8
Borup silt loam: (S77ND-035-016)																		
C2ca-----24 to 37	A-4(05)	ML	100	100	100	100	100	100	--	16	--	31	4	109	17	23.0	0.0	1.6
C4-------37 to 60	A-4(07)	ML	100	100	100	100	100	100	--	20	--	31	6	111	17	23.0	0.0	1.6
Cashel silty clay loam: (S77ND-035-029)																		
C1------- 9 to 22	A-7-6(28)	CH	100	100	100	100	100	99	--	43	--	51	24	104	19	19.0	0.0	1.7
C2-------22 to 60	A-7-6(29)	CH	100	100	100	100	100	99	--	41	--	51	25	105	18	17.0	0.0	1.8
Embden fine sandy loam: (S77ND-035-036)																		
B2-------15 to 26	A-4(01)	SC	100	100	100	100	99	42	--	21	--	31	10	108	17	18.0	0.0	1.7
C1-------26 to 37	A-4(01)	SM	100	100	100	100	100	41	--	17	--	34	10	105	18	20.0	0.0	1.6
Exline silty clay: (S77ND-035-009)																		
B21t----- 8 to 21	A-7-5(43)	CH	100	100	100	100	98	91	--	67	--	73	40	108	17	12.0	0.0	1.9
C2ca-----35 to 40	A-6(11)	CL	100	100	100	100	93	70	--	31	--	36	18	125	11	17.0	0.0	1.8
Gardena silt loam: (S77ND-035-002)																		
B2-------14 to 28	A-4(05)	ML	100	100	100	100	98	72	--	18	--	33	8	109	16	20.0	0.0	1.7
C1-------28 to 60	A-4(03)	ML	100	100	100	99	97	67	--	20	--	33	6	111	15	21.0	0.0	1.6
Glyndon silt loam: (S77ND-035-022)																		
C3-------25 to 40	A-4(00)	ML	100	100	100	100	100	94	--	12	--	--	NP	96	24	0.0	0.0	0.0
C4-------40 to 60	A-4(00)	ML	100	100	100	100	99	88	--	14	--	--	NP	101	22	0.0	0.0	0.0
Inkster sandy loam: (S76ND-035-014)																		
B2-------22 to 33	A-2-6(00)	SC	100	100	100	100	74	33	--	14	--	33	11	106	18	18.0	0.0	1.7
C1-------33 to 50	A-2-6(00)	SC	100	100	100	100	62	33	--	17	--	36	12	104	19	21.0	0.0	1.6

TABLE 16.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution									Liquid limit	Plasticity index	Moisture density		Shrinkage		
			Percentage passing sieve--						Percentage smaller than--									
	AASHTO	Unified	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Maximum density	Optimum moisture	Limit	Linear	Ratio
												Pct		Lb/Ft3	Pct	Pct	Pct	Pct
Ojata silty clay loam: (S77ND-035-006)																		
C2--------23 to 37	A-6(19)	CL	100	100	100	100	100	99	--	37	--	39	18	111	16	16.0	0.0	1.9
C3--------37 to 60	A-6(19)	CL	100	100	100	100	100	99	--	33	--	40	17	108	18	18.0	0.0	1.8
Overly silty clay loam: (S77ND-035-004)																		
B2--------15 to 22	A-7-6(18)	ML	100	100	100	100	99	88	--	32	--	46	18	105	19	19.0	0.0	1.7
C1ca------22 to 32	A-7-6(21)	ML	100	100	100	100	100	98	--	43	--	45	18	104	19	21.0	0.0	1.6
Parnell silt loam: (S77ND-035-014)																		
B21tg-----14 to 35	A-7-6(26)	CH	100	100	100	100	98	87	--	52	--	52	27	106	18	14.0	0.0	1.8
C1g-------35 to 60	A-7-6(21)	CL	100	100	100	99	98	92	--	43	--	43	22	112	15	16.0	0.0	1.8
Walsh loam: (S77ND-035-011)																		
B2------- 8 to 23	A-7-6(13)	CL	100	100	100	100	99	68	--	42	--	45	20	88	26	15.0	0.0	1.8
C1--------32 to 40	A-6(05)	CL	100	100	100	100	98	52	--	25	--	40	15	90	25	21.0	0.0	1.6

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
*Aberdeen	Fine, montmorillonitic Glossic Udic Natriborolls
Antler	Fine-loamy, frigid Aeric Calciaquolls
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Borup	Coarse-silty, frigid Typic Calciaquolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cashel	Fine, montmorillonitic, frigid Mollic Udifluvents
Cavour	Fine, montmorillonitic Udic Natriborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Dovray	Fine, montmorillonitic, frigid Cumulic Haplaquolls
Edgeley	Fine-loamy, mixed Udic Haploborolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Exline	Fine, montmorillonitic Leptic Natriborolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Gilby	Fine-loamy, frigid Aeric Calciaquolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Grimstad	Sandy over loamy, frigid Aeric Calciaquolls
Hamar	Sandy, mixed, frigid Typic Haplaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
*Hecla	Sandy, mixed Aquic Haploborolls
Inkster	Coarse-loamy, mixed Pachic Udic Haploborolls
Kloten	Loamy, mixed Lithic Haploborolls
LaDelle	Fine-silty, mixed Cumulic Udic Haploborolls
Lallie	Fine, montmorillonitic (calcareous), frigid Typic Fluvaquents
Lamoure	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Maddock	Sandy, mixed Udorthentic Haploborolls
*Manfred	Fine-loamy, mixed, frigid Typic Natraquolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
*Miranda	Fine-loamy, mixed Leptic Natriborolls
Miranda Variant	Fine, mixed Leptic Natriborolls
Nutley	Fine, montmorillonitic Udertic Haploborolls
Ojata	Fine-silty, frigid Typic Calciaquolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Perella	Fine-silty, mixed, frigid Typic Haplaquolls
Rauville	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Rockwell	Coarse-loamy, frigid Typic Calciaquolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Tiffany	Coarse-loamy, mixed, frigid Typic Haplaquolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Vang	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Velva	Coarse-loamy, mixed Fluventic Haploborolls
Wahpeton	Fine, montmorillonitic Udertic Haploborolls
Walsh	Fine-loamy, mixed Pachic Udic Haploborolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls
Zell	Coarse-silty, mixed Udorthentic Haploborolls

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NRCS Accessibility Statement

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

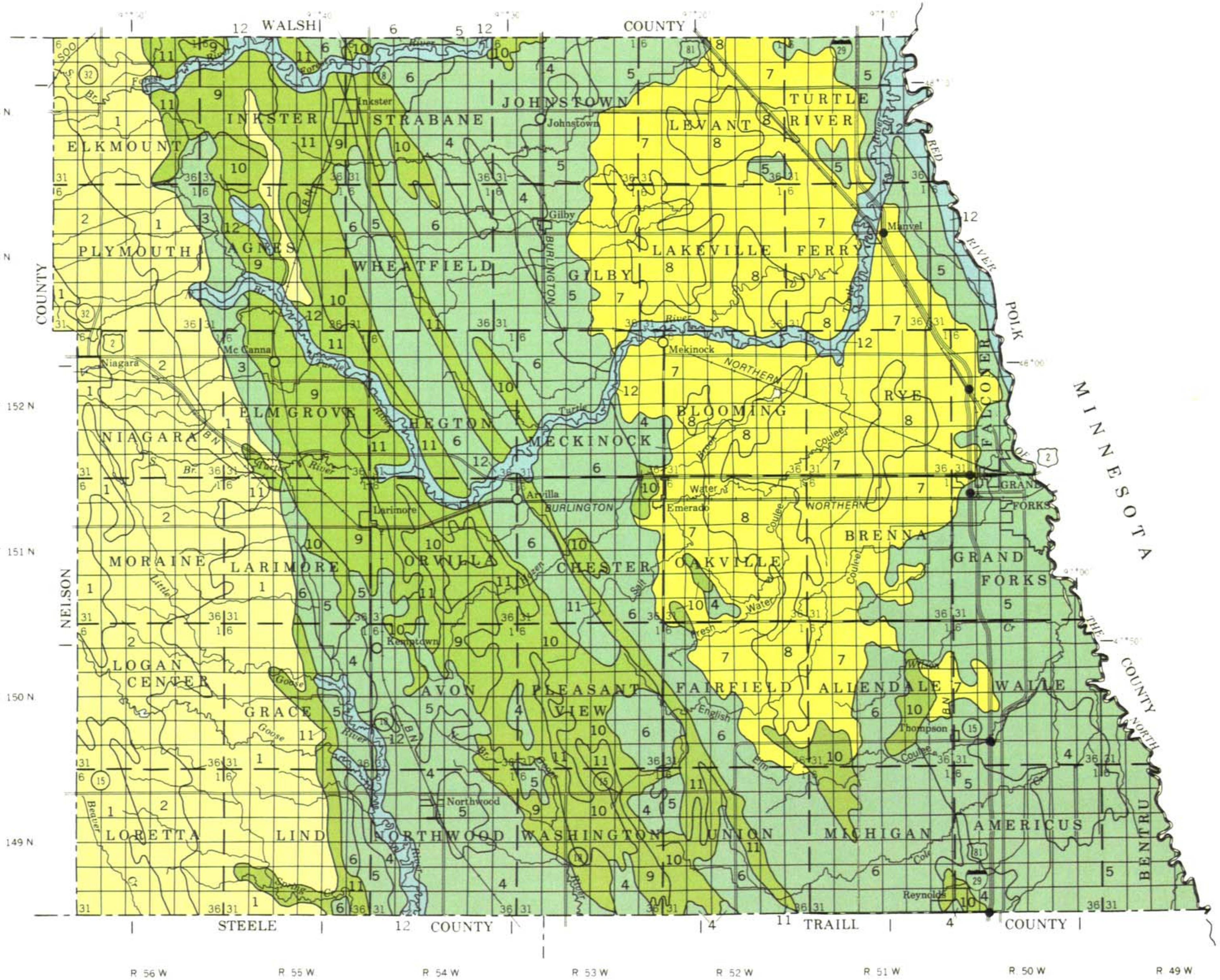
GENERAL SOIL MAP

GRAND FORKS COUNTY, NORTH DAKOTA

Scale 1: 316,800

1 0 1 2 3 4 5 Miles

1 0 1 2 3 4 5 6 7 8 Kilometers



SOIL LEGEND*

DOMINANTLY LEVEL TO MODERATELY SLOPING, MEDIUM TEXTURED SOILS

1 Svea-Buse-Hamerly association: Deep, nearly level to moderately sloping, well drained to somewhat poorly drained, medium textured soils

2 Barnes-Cresbard-Cavour association: Deep, level to gently sloping, well drained and moderately well drained, medium textured soils

DOMINANTLY LEVEL AND NEARLY LEVEL, FINE TEXTURED TO MEDIUM TEXTURED SOILS

3 Nutley-Aberdeen association: Deep, level, well drained and moderately well drained, fine textured soils

4 Glyndon-Gardena association: Deep, level and nearly level, somewhat poorly drained and moderately well drained, medium textured soils

5 Bearden association: Deep, level, somewhat poorly drained, moderately fine textured and fine textured soils

6 Antler-Gilby-Svea association: Deep, level and nearly level, somewhat poorly drained and moderately well drained, medium textured soils

DOMINANTLY LEVEL, MODERATELY FINE TEXTURED, SALINE SOILS

7 Bearden-Antler association: Deep, level, somewhat poorly drained, moderately fine textured, saline soils

8 Ojata association: Deep, level, poorly drained, moderately fine textured, very strongly saline soils

DOMINANTLY LEVEL TO GENTLY SLOPING, MEDIUM TEXTURED AND MODERATELY COARSE TEXTURED SOILS

9 Embden-Inkster association: Deep, level to gently sloping, moderately well drained, moderately coarse-textured soils

10 Wyndmere-Tiffany-Arveson association: Deep, level, somewhat poorly drained and poorly drained, medium textured and moderately coarse textured soils

11 Arvilla-Hecla association: Deep, nearly level and gently sloping, somewhat excessively drained and moderately well drained, moderately coarse textured soils

DOMINANTLY LEVEL TO MODERATELY STEEP, MEDIUM TEXTURED AND MODERATELY FINE TEXTURED SOILS THAT ARE SUBJECT TO FLOODING

12 LaDelle-Cashel association: Deep, level to moderately steep, moderately well drained and somewhat poorly drained, medium textured and moderately fine textured soils

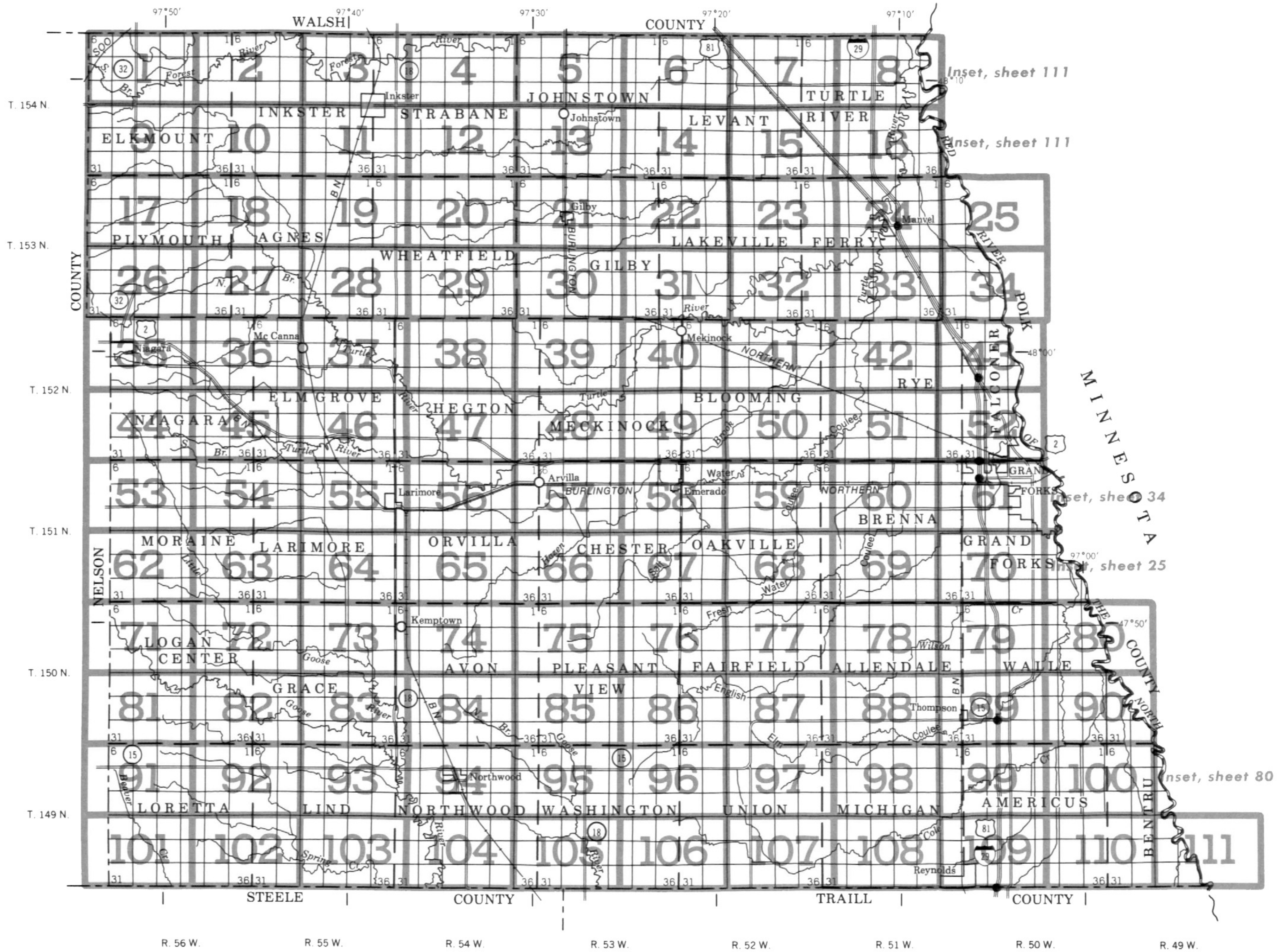
*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association.

Compiled 1980

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS
GRAND FORKS COUNTY, NORTH DAKOTA

Scale 1: 316,800

1 0 1 2 3 4 5 Miles

1 0 1 2 3 4 5 6 7 8 Kilometers

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Original text from each individual map sheet read:

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME	SYMBOL	NAME
2	Parnell silt loam	64	Antler silt loam
3	Vallers loam	65	Antler silty clay loam, saline
4	Arveson loam	67	Gilby loam
8	Colvin silty clay loam	70	Antler-Tonka silty clay loams, saline
10	Lamoure silty clay loam	71	Hamerly-Tonka complex, 0 to 3 percent slopes
11	Dovray clay	72	Gardena silt loam, 0 to 3 percent slopes
12	Svea loam, 0 to 3 percent slopes	73	Glyndon silt loam, 0 to 3 percent slopes
13B	Barnes loam, 3 to 6 percent slopes	76	Borup silt loam
15D	Buse-Svea loams, 1 to 15 percent slopes	78B	Zell-Gardena silt loams, 1 to 6 percent slopes
15E	Buse-Svea loams, 1 to 25 percent slopes	78C	Zell-Gardena silt loams, 1 to 9 percent slopes
16	Lallie silty clay loam, ponded	79B	Zell-LaDelle silt loams, 1 to 6 percent slopes
17	Vang loam, 0 to 3 percent slopes	79C	Zell-LaDelle silt loams, 1 to 9 percent slopes
19	Hamerly loam, 1 to 3 percent slopes	79D	Zell-LaDelle silt loams, 1 to 15 percent slopes
23	Cresbard-Cavour loams, 0 to 3 percent slopes	84	Wyndmere-Embden sandy loams
23B	Barnes-Cresbard loams, 1 to 6 percent slopes	86	Divide loam, 1 to 3 percent slopes
25	Overly silty clay loam, 0 to 3 percent slopes	87	Marysland loam
26	Bearden-Overly silty clay loams, 0 to 3 percent slopes	89	Renshaw loam, 1 to 3 percent slopes
29	Velva sandy loam, 1 to 3 percent slopes	89B	Renshaw loam, 3 to 6 percent slopes
30	Walsh loam, 0 to 3 percent slopes	90B	Arvilla sandy loam, 1 to 6 percent slopes
35	Rauville silt loam	93	Inkster sandy loam, 0 to 3 percent slopes
39	Vallers-Manfred clay loams, saline	94	Pits, gravel
41	Bearden-Perella silty clays	95	Ojata silty clay loam
42	Nutley silty clay	96D	Sioux-Barnes loams, 6 to 15 percent slopes
43B	Cashel silty clay loam, 1 to 6 percent slopes	97D	Sioux loam, 1 to 15 percent slopes
43E	Cashel silty clay loam, 6 to 25 percent slopes	98E	Edgeley-Kloten loams, 6 to 25 percent slopes
45	Wahpeton silty clay, 1 to 3 percent slopes	99	Cavour-Miranda loams, 0 to 3 percent slopes
46	LaDelle silt loam, 0 to 3 percent slopes	126	Bearden silty clay loam
48	Wyndmere sandy loam	130B	Svea-Buse loams, 1 to 6 percent slopes
50B	Hecla fine sandy loam, 1 to 6 percent slopes	130C	Buse-Svea loams, 1 to 9 percent slopes
51B	Hecla-Maddock fine sandy loams, 1 to 6 percent slopes	148	Wyndmere-Tiffany fine sandy loams
51E	Maddock sandy loam, 9 to 25 percent slopes	171	Antler-Tonka silt loams
53	Hamar sandy loam	173	Glyndon-Tiffany silt loams
54B	Embden fine sandy loam, 1 to 6 percent slopes	199D	Miranda Variant loam, 1 to 15 percent slopes
55	Tiffany loam	226	Bearden-Perella silty clay loams
59	Towner fine sandy loam, 1 to 3 percent slopes	270	Bearden silty clay loam, saline
60	Grimstad fine sandy loam	401	Aberdeen-Nutley silty clays
62	Rockwell fine sandy loam	402	Exline-Aberdeen silty clays

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (51B 126)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

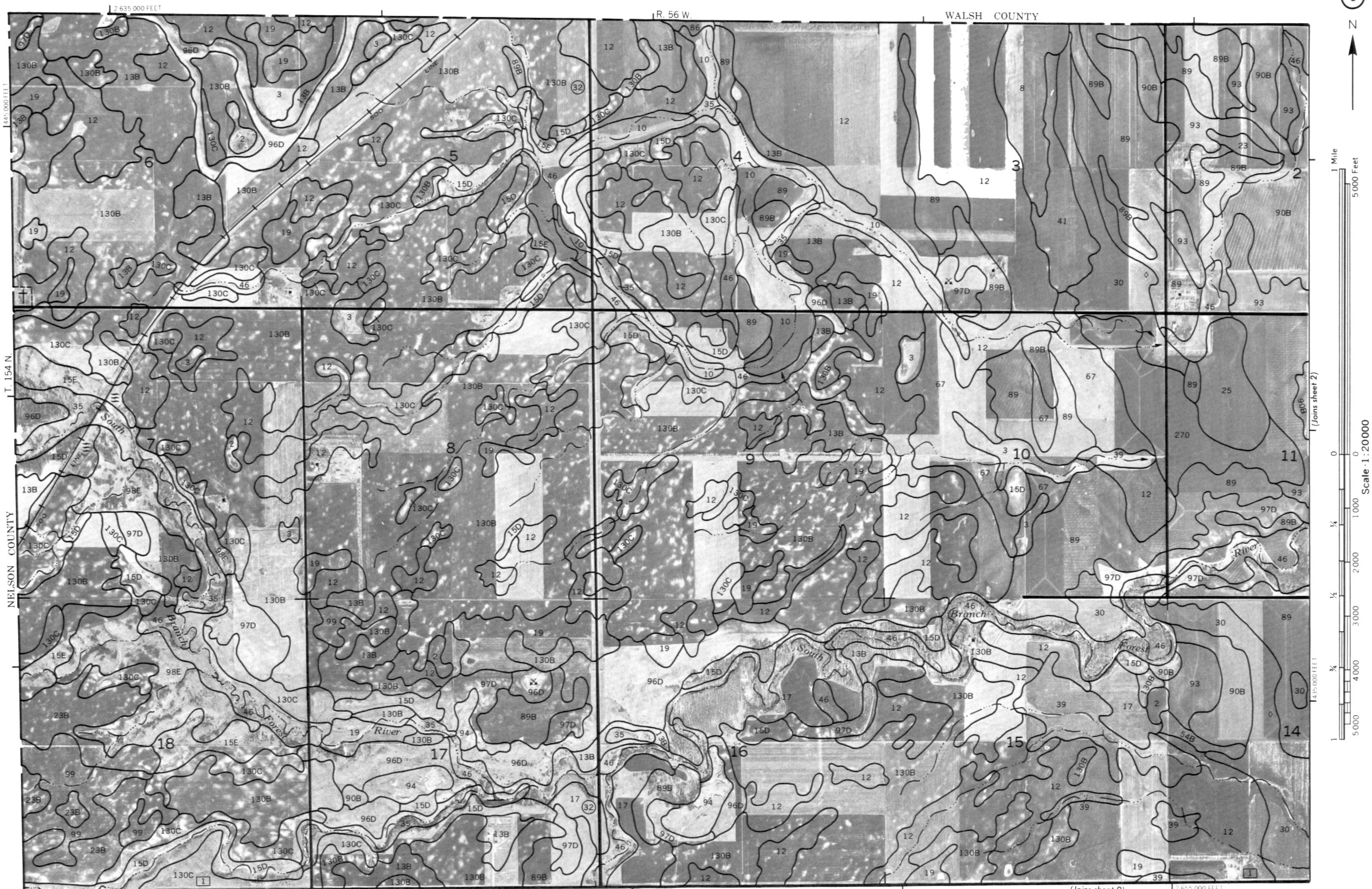
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

1



2 635 000 FEET
R. 56 W.
WALSH COUNTY
N
T. 154 N.
NELSON COUNTY
South Branch
Forest River
SOO LINE
(Joins sheet 2)
(Joins sheet 9)
2 655 000 FEET
1 Mile
5000 Feet
Scale 1:20000

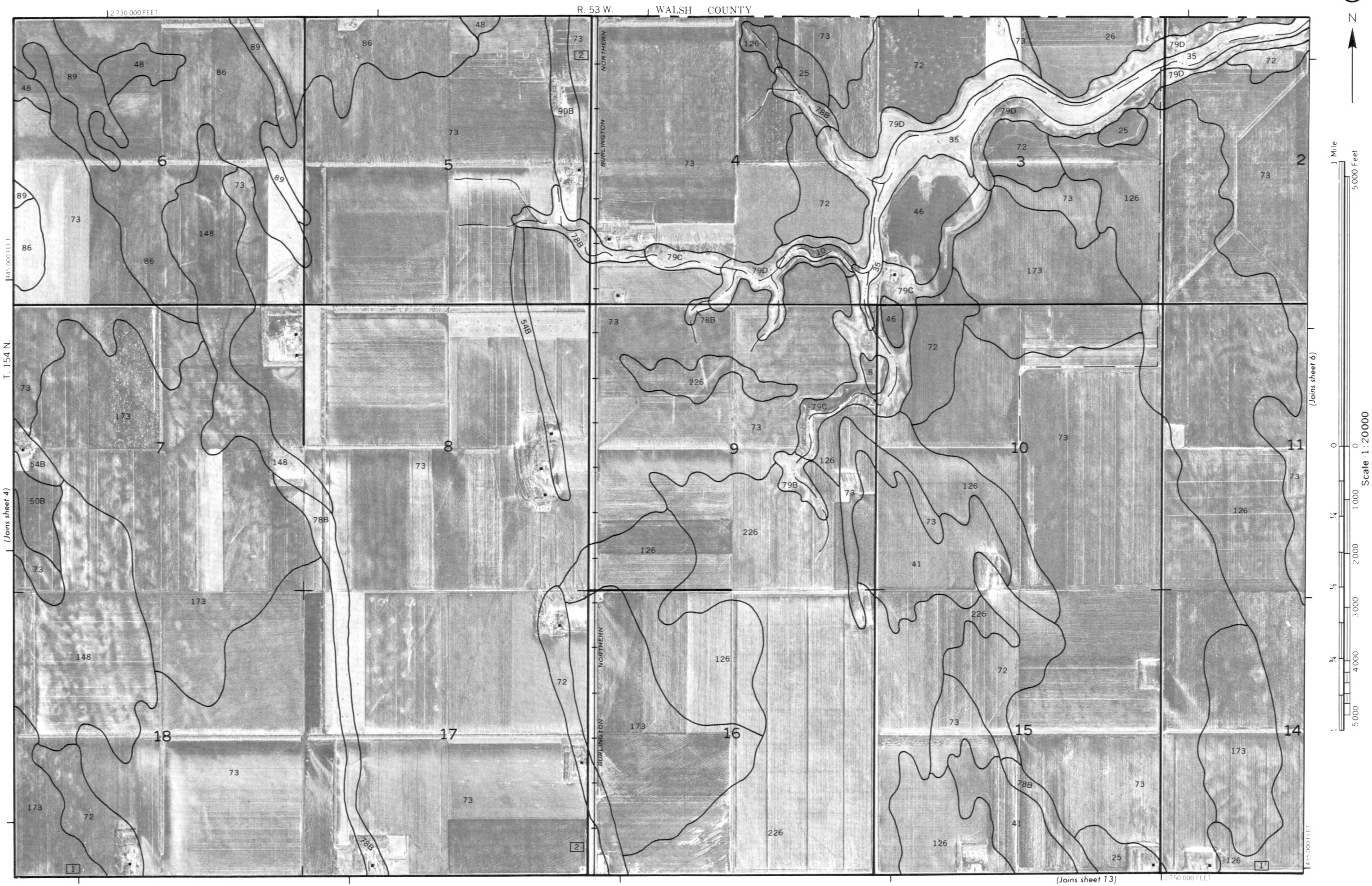

2
N
WALSH COUNTY
R. 56 W.
R. 55 W.
2 680 000 FEET
445 000 FEET
435 000 FEET
2 660 000 FEET
T. 154 N.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 10)
Scale 1:20000
1 Mile
5000 Feet
Forest River
South Branch Forest River


WALSH COUNTY
R. 55 W.
R. 54 W.
T. 154 N.
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 11)
Inkster
BURLINGTON NORTHERN
Forest River
2 685 000 FEET
2 705 000 FEET
445 000 FEET
435 000 FEET

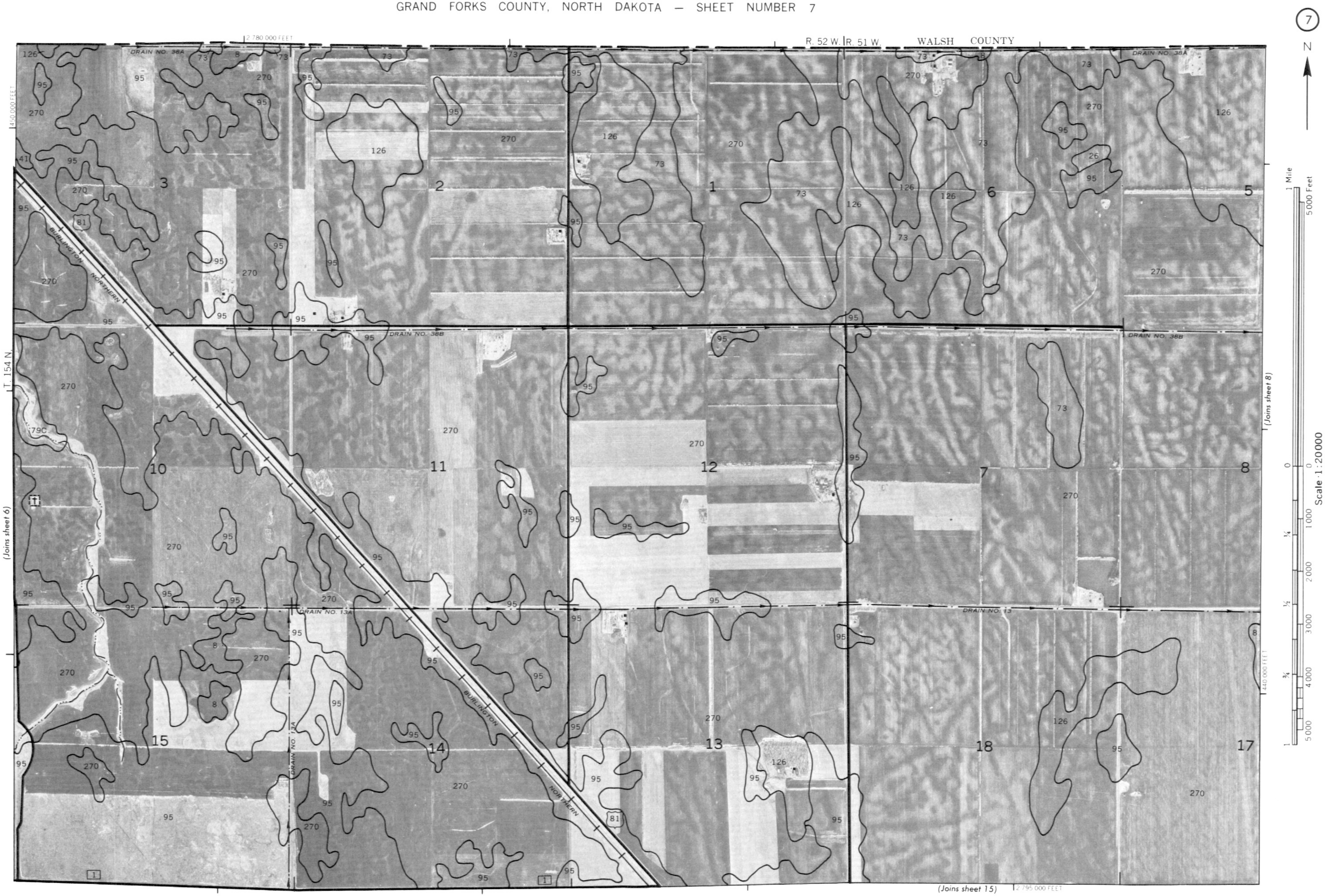
3
N
1 Mile
5000 Feet
Scale 1:20000

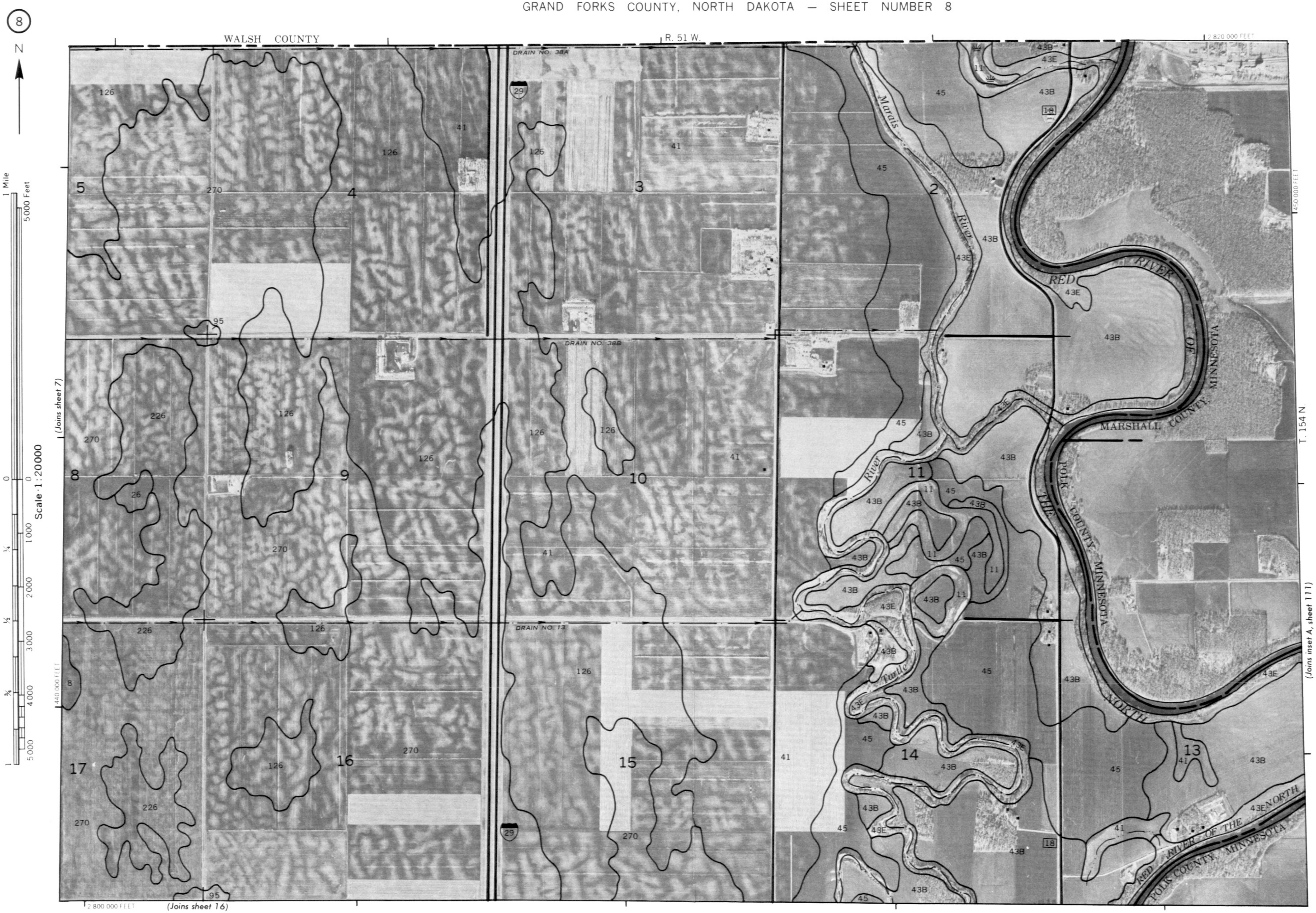

4
N
R. 54 W.
WALSH COUNTY
2 725 000 FEET
445 000 FEET
T. 154 N.
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 12)
2 710 000 FEET
435 000 FEET
Forest River
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000

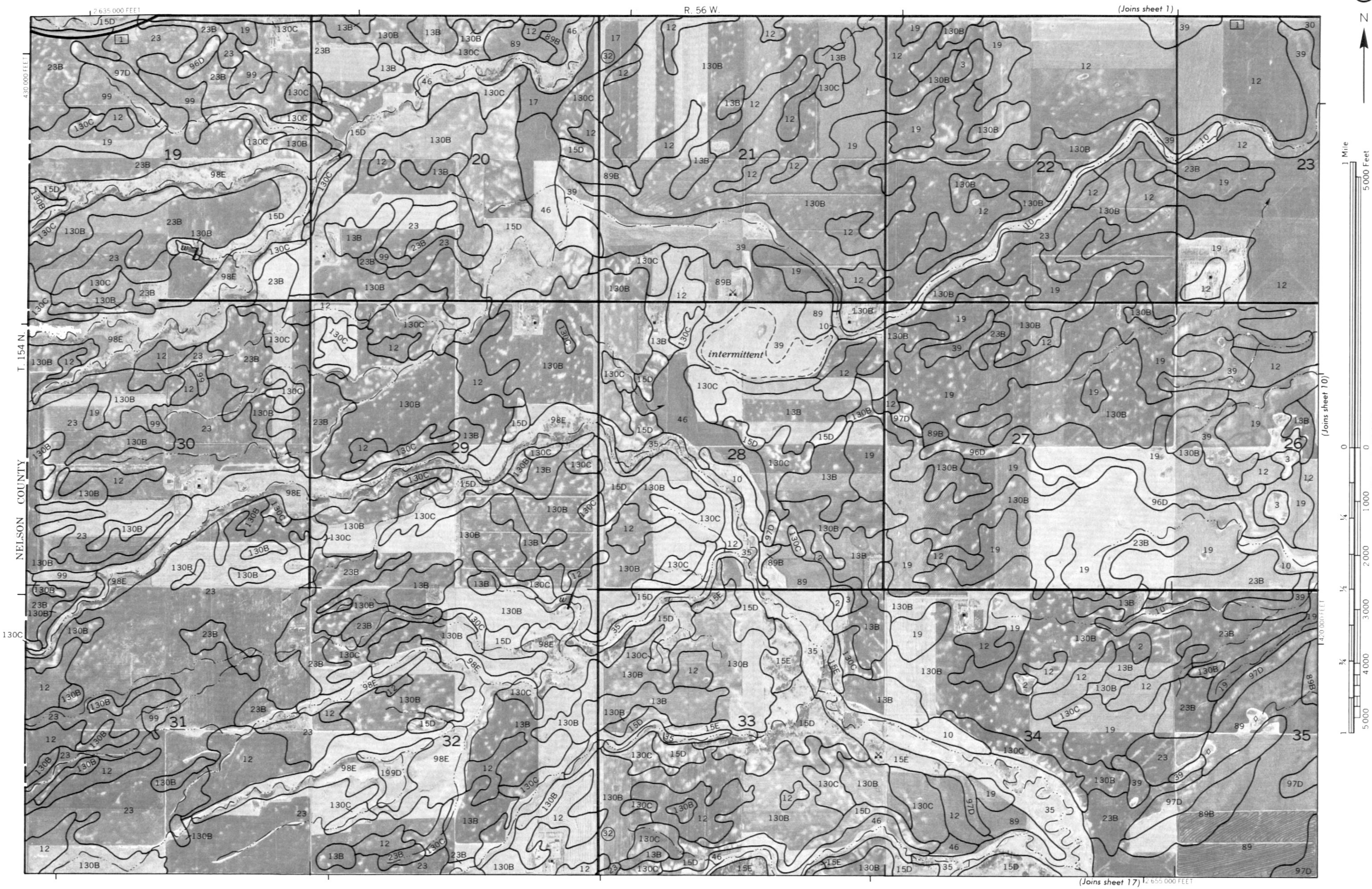
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 5



GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 6


7
N
2 780 000 FEET
R. 52 W.
R. 51 W.
WALSH COUNTY
DRAIN NO. 38A
DRAIN NO. 38B
DRAIN NO. 13A
DRAIN NO. 13
BURLINGTON NORTHERN
450 000 FEET
T. 154 N.
(Joins sheet 6)
(Joins sheet 8)
(Joins sheet 15)
440 000 FEET
2 795 000 FEET
1 Mile
5 000 Feet
Scale 1:20000


8
N
1 Mile
5000 Feet
Scale 1:20000
WALSH COUNTY
R. 51 W.
2 820 000 FEET
450 000 FEET
440 000 FEET
2 800 000 FEET
T. 154 N
(Joins sheet 7)
(Joins sheet 16)
(Joins inset A, sheet 111)
DRAIN NO. 38A
DRAIN NO. 38B
DRAIN NO. 13
Marais River
Turtle River
RED RIVER OF THE NORTH
MARSHALL COUNTY, MINNESOTA
POLK COUNTY, MINNESOTA
29
18
2
3
4
5
8
9
10
11
13
14
15
16
17
126
270
41
45
43B
43E
11
95
226
26

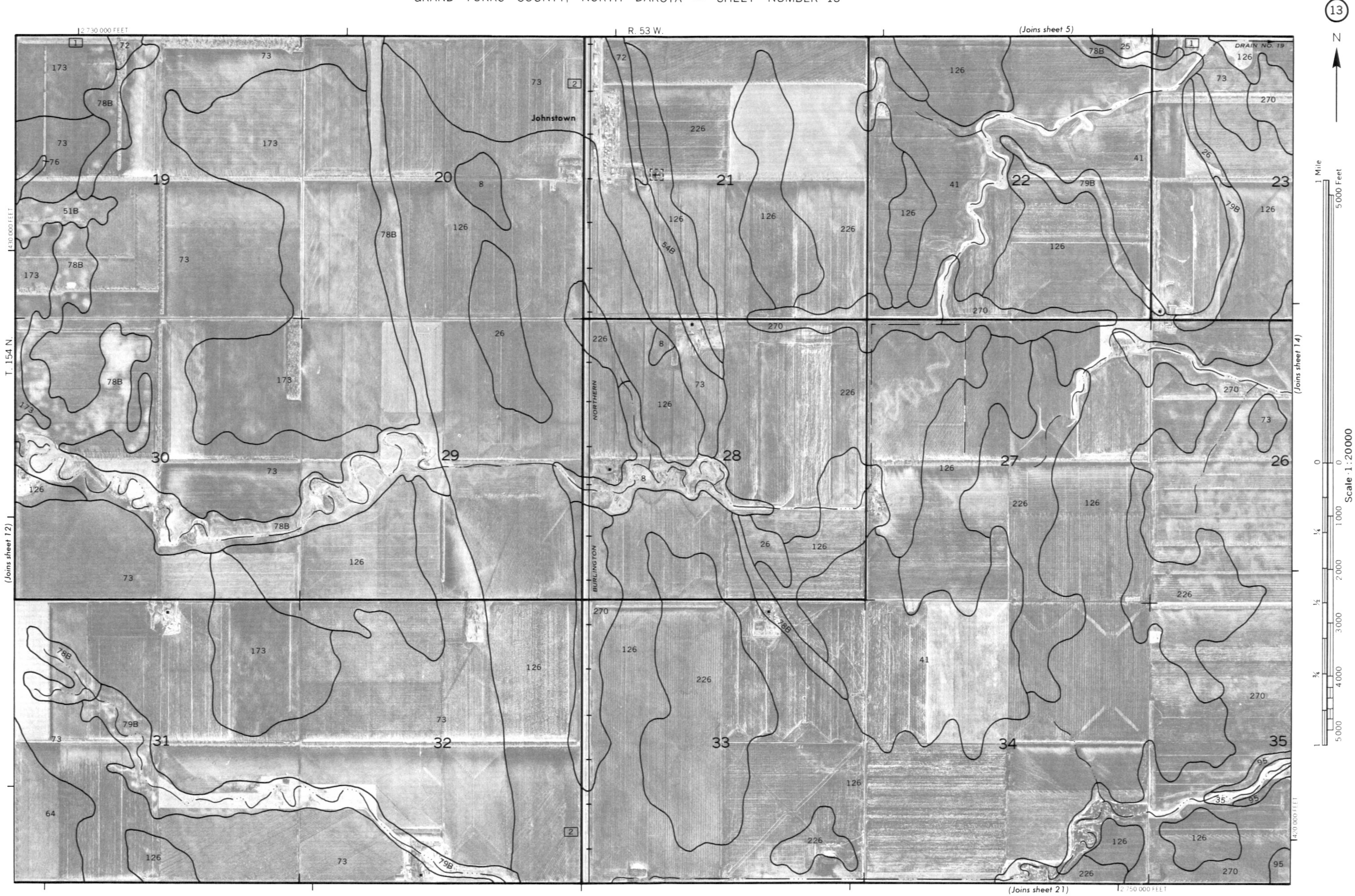

R. 56 W.
(Joins sheet 1)
(Joins sheet 10)
(Joins sheet 17)
T. 154 N.
NELSON COUNTY
2 635 000 FEET
430 000 FEET
2 655 000 FEET
intermittent
N
1 Mile
5000 Feet
Scale 1:20000

GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 10

GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 11


(Joins sheet 4)
R. 54 W.
2 725 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 11)
T. 154 N.
(Joins sheet 13)
430 000 FEET
420 000 FEET
(Joins sheet 20)
2 710 000 FEET
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36

GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 13

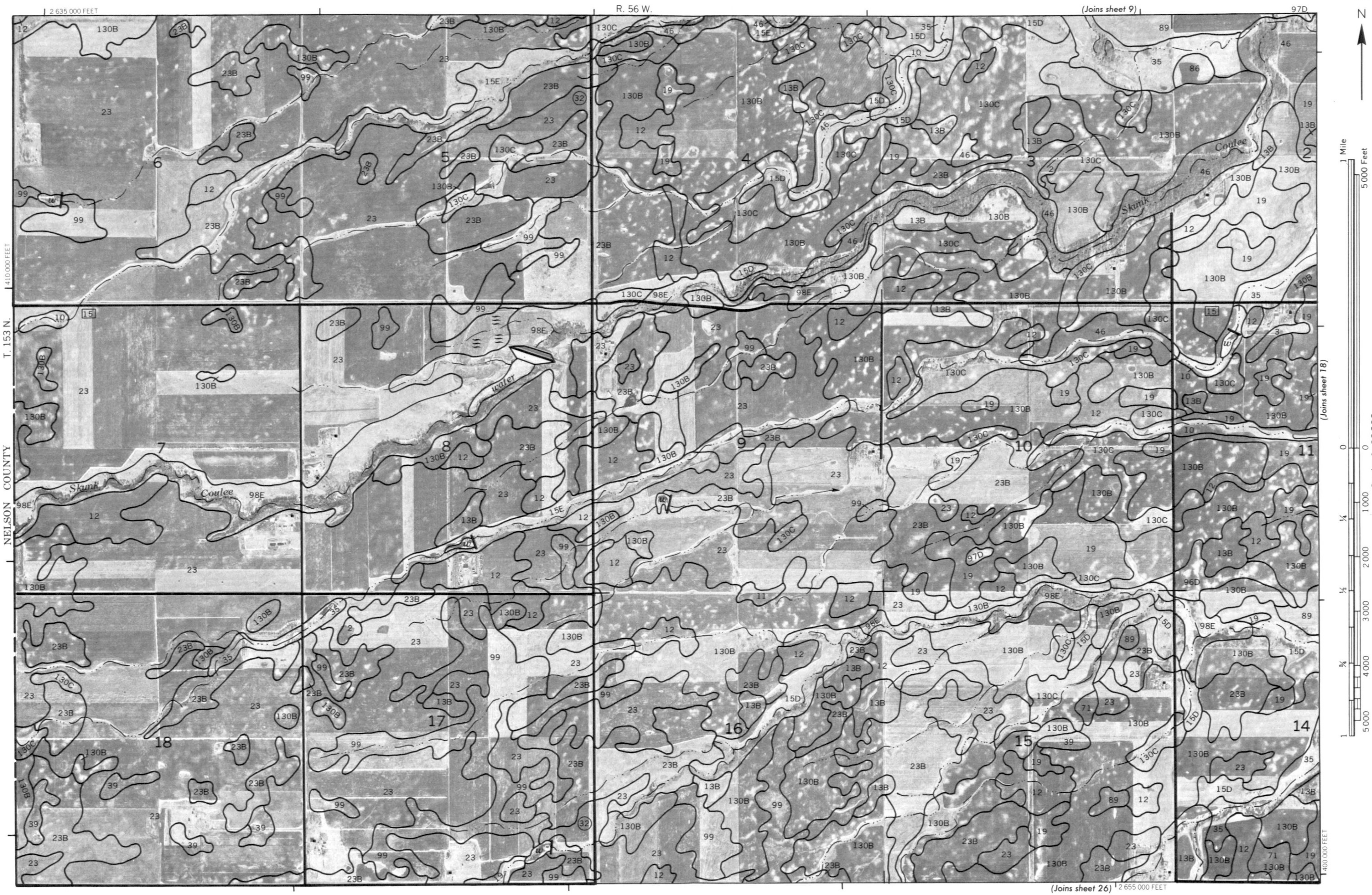


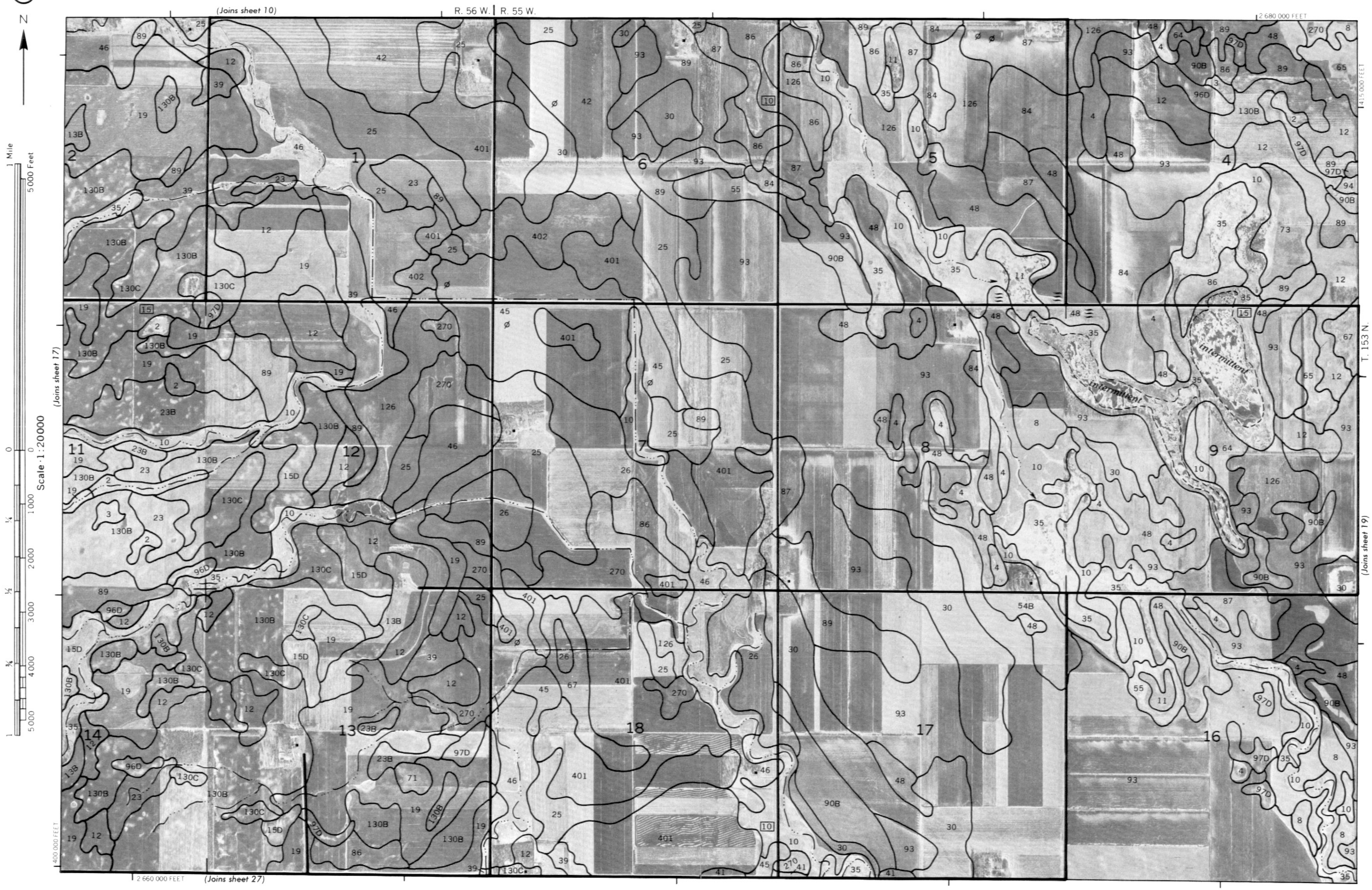

R. 53 W.
R. 52 W.
(Joins sheet 6)
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 22)
T. 154 N.
DRAIN NO. 19
DRAIN NO. 12
2 775 000 FEET
2 755 000 FEET
435 000 FEET
420 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

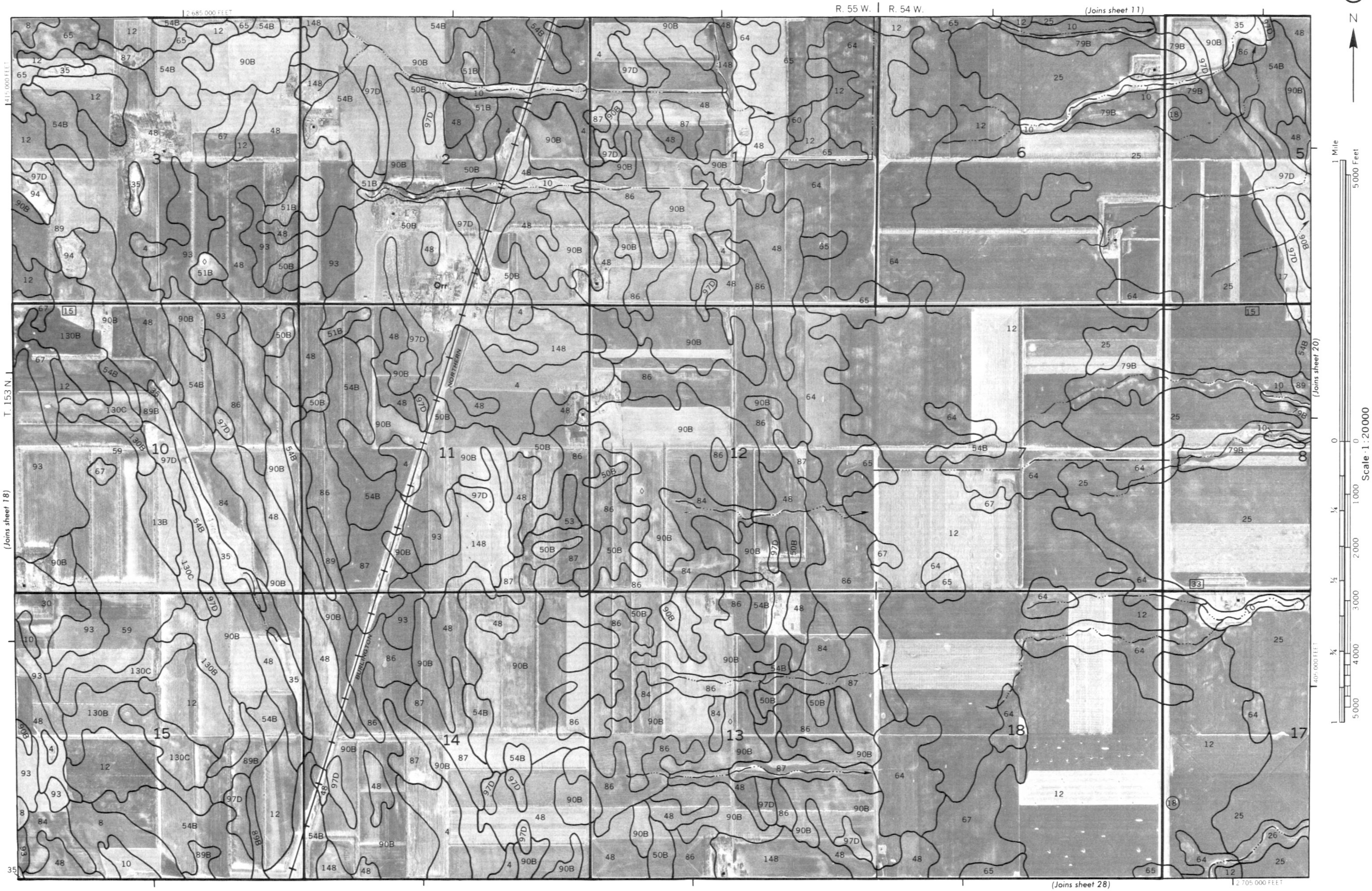

N
R. 52 W.
R. 51 W.
T. 154 N.
(Joins sheet 7)
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 23)
2 780 000 FEET
435 000 FEET
DRAIN NO. 13A
DRAIN NO. 2
DRAIN NO. 1
DRAIN NO. 3
BURLINGTON NORTHERN
81
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
95
126
270
73
1 Mile
5000 Feet
Scale 1:20000

(16)

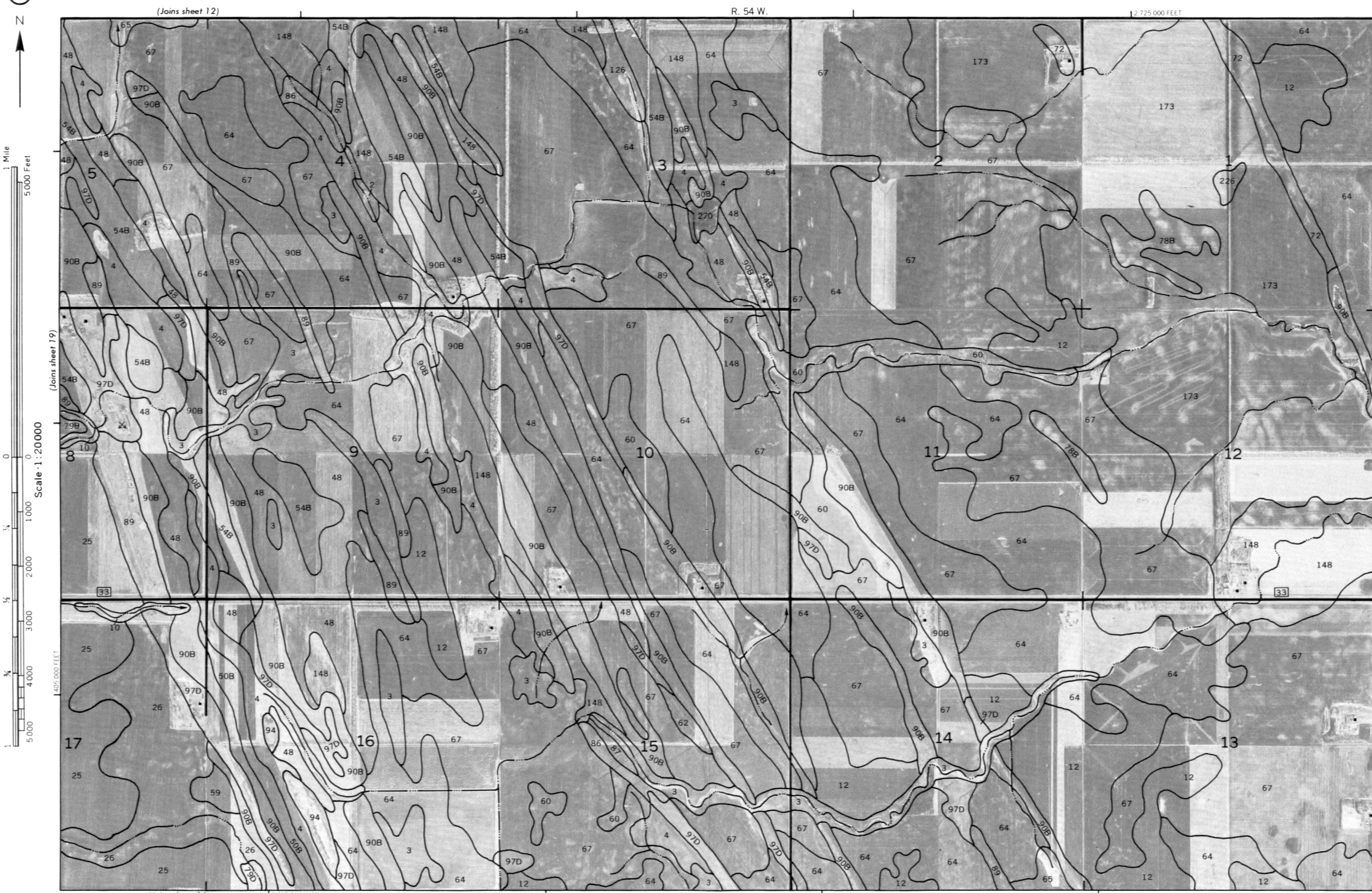

N
(Joins sheet 8)
R. 51 W.
2 820 000 FEET
435 000 FEET
(Joins sheet 15)
T. 151 N.
(Joins inset B, sheet 111)
425 000 FEET
2 800 000 FEET
(Joins sheet 24)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
DRAIN NO. 3
DRAIN NO. 1
BURLINGTON NORTHERN
Turtle River
South Marais River
RED RIVER OF THE NORTH
POLK COUNTY MINNESOTA
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


2 635 000 FEET
R. 56 W.
(Joins sheet 9)
N
1 Mile
5000 Feet
410 000 FEET
T. 153 N.
NELSON COUNTY
(Joins sheet 18)
Scale 1:20000
Skunk Coulee
water
(Joins sheet 26)
2 655 000 FEET
400 000 FEET


N
(Joins sheet 10)
R. 56 W.
R. 55 W.
2 680 000 FEET
415 000 FEET
T. 153 N.
(Joins sheet 19)
(Joins sheet 17)
(Joins sheet 27)
2 660 000 FEET
400 000 FEET
1 Mile
5000 Feet
Scale 1:20000

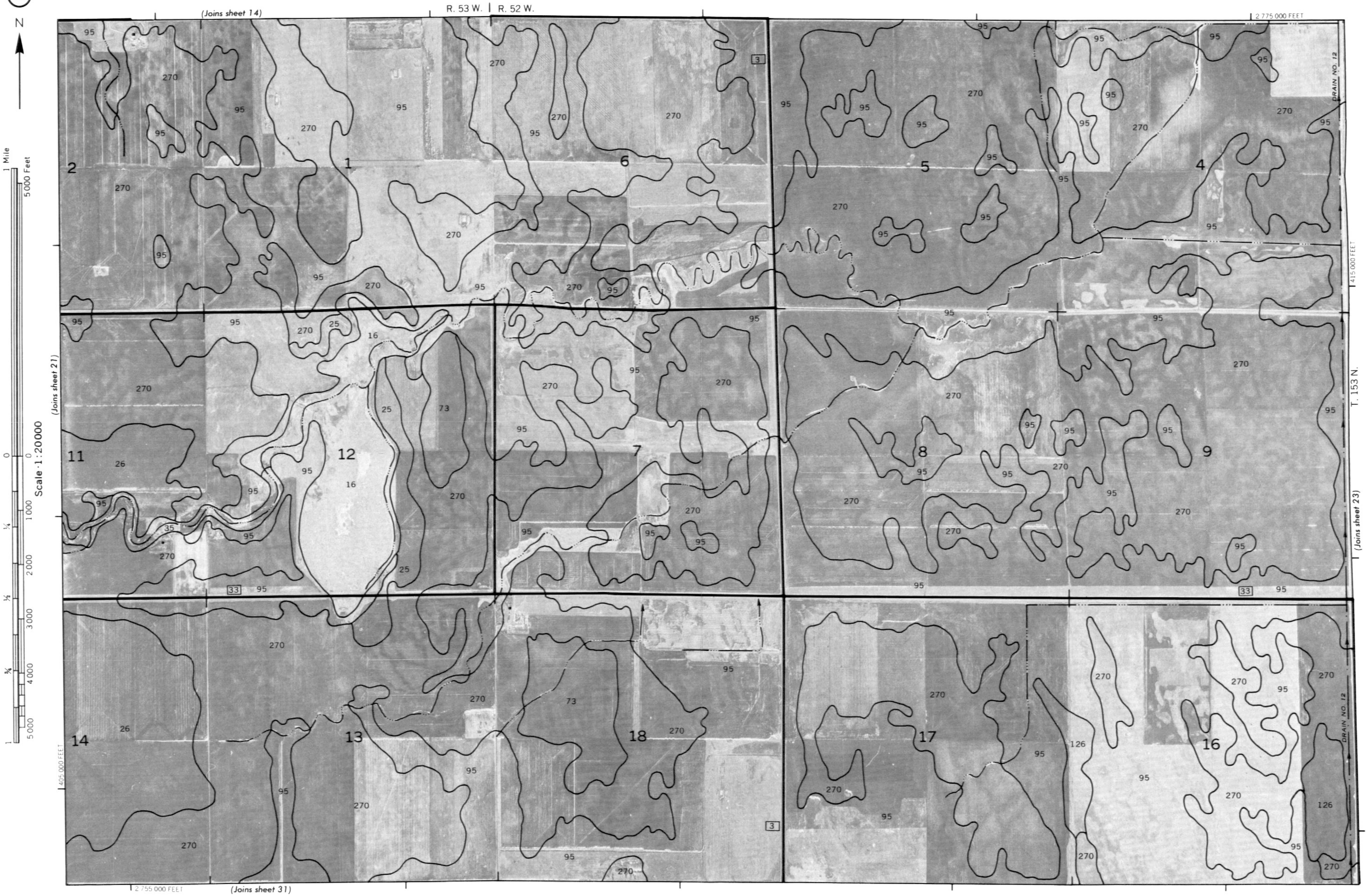

19
N
R. 55 W.
R. 54 W.
(Joins sheet 11)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 28)
T. 153 N.
2 685 000 FEET
2 705 000 FEET
415 000 FEET
405 000 FEET
Orr
NORTHERN
BURLINGTON
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1

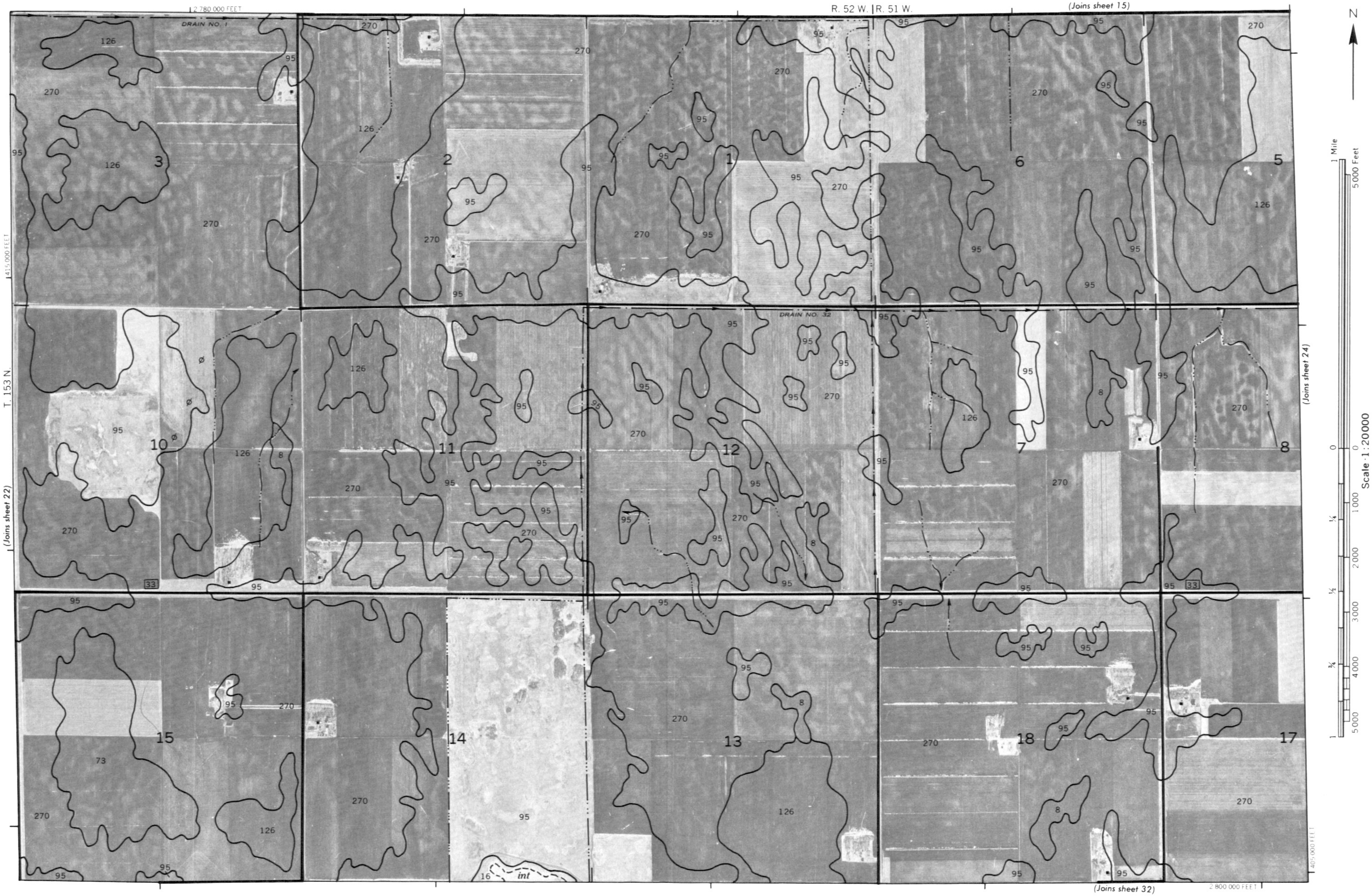
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 20



21

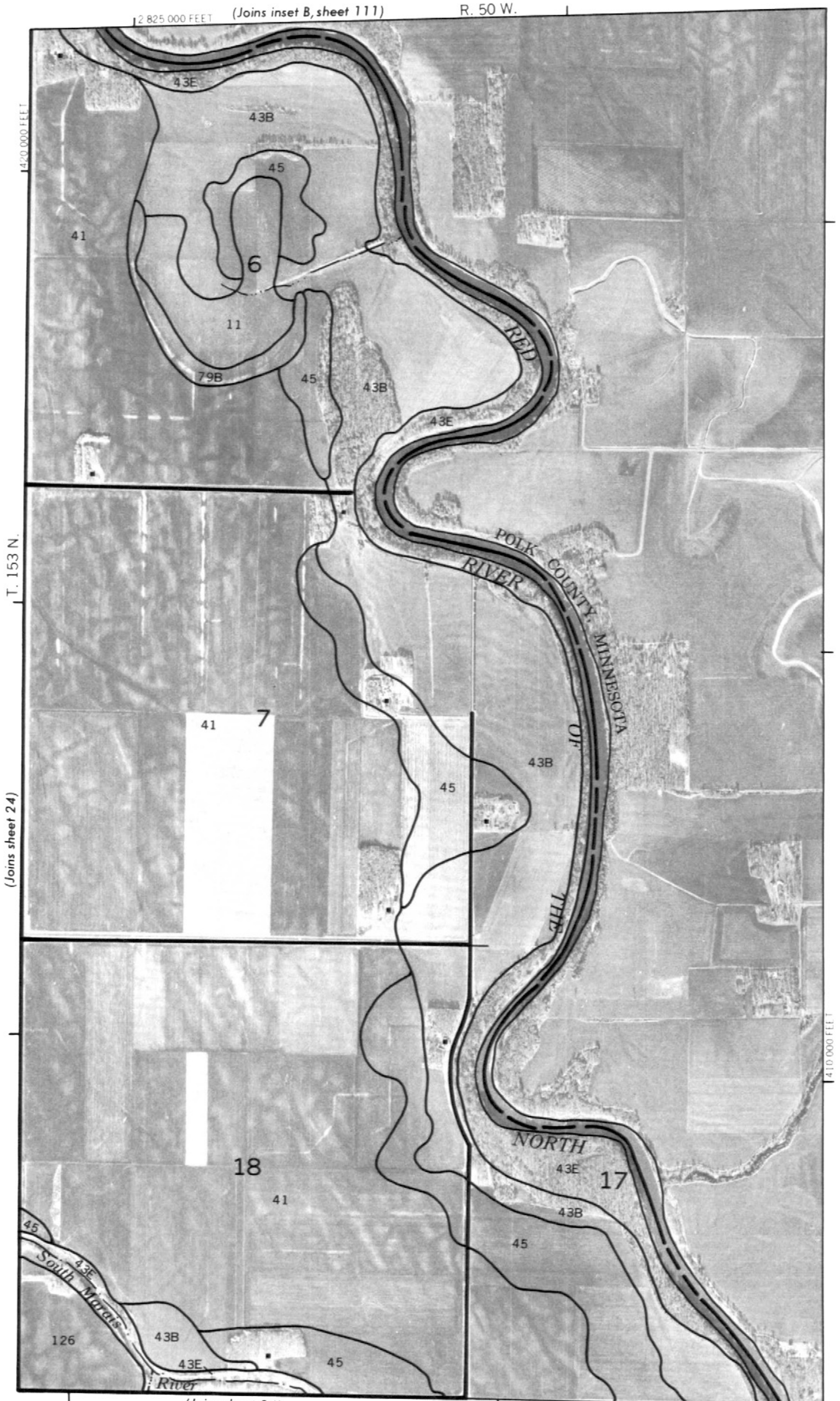

(Joins sheet 13)
(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 20)
R. 53 W.
T. 153 N.
2 730 000 FEET
2 750 000 FEET
BURLINGTON NORTHERN
Gilby
LAGOON
N
Scale 1:20000
1 Mile
5000 Feet

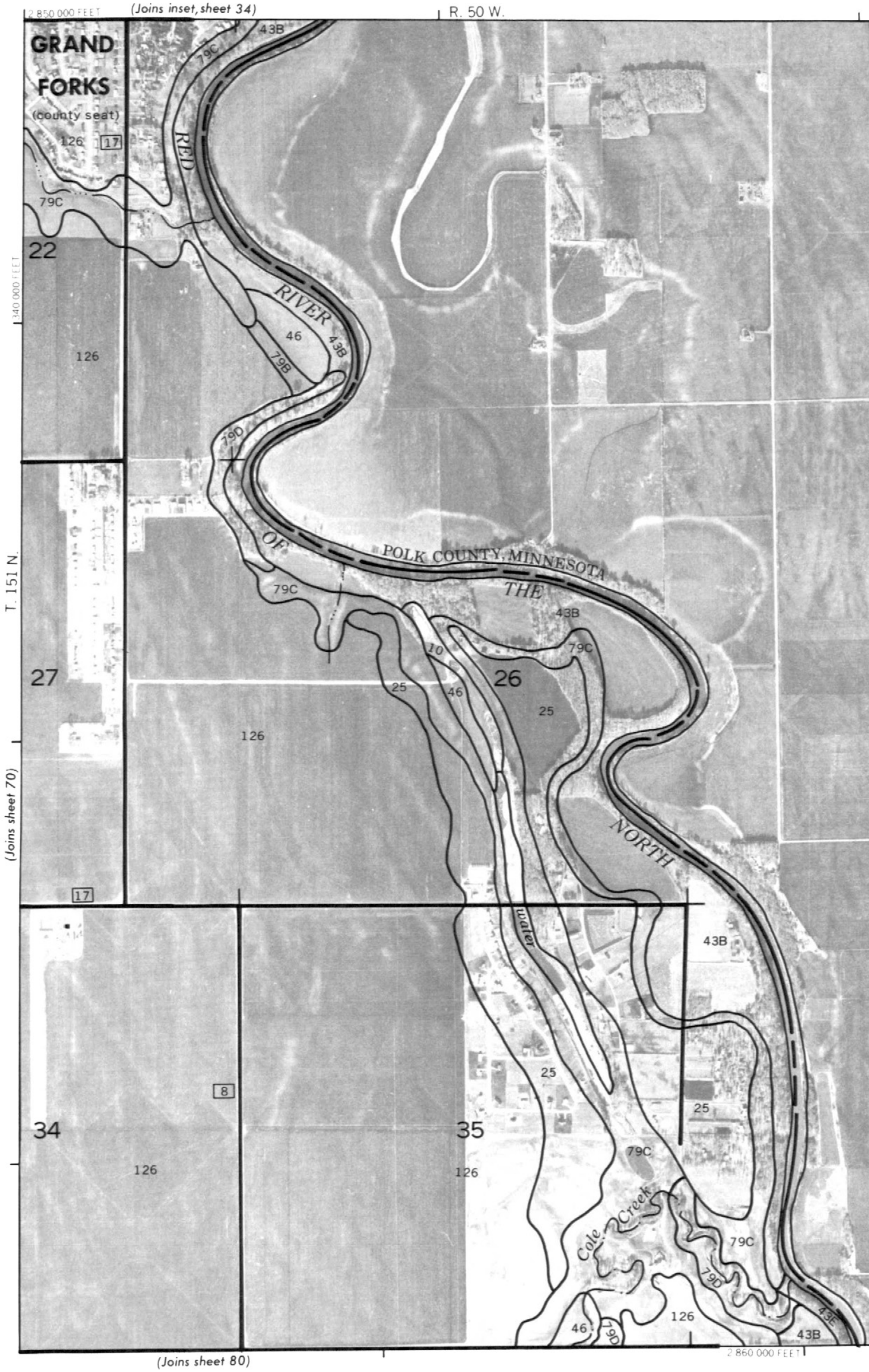

N
(Joins sheet 14)
R. 53 W.
R. 52 W.
2 775 000 FEET
DRAIN NO. 12
415 000 FEET
T. 153 N.
(Joins sheet 23)
(Joins sheet 21)
(Joins sheet 31)
2 755 000 FEET
405 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
2
3
4
5
6
7
8
9
11
12
13
14
16
17
18
33

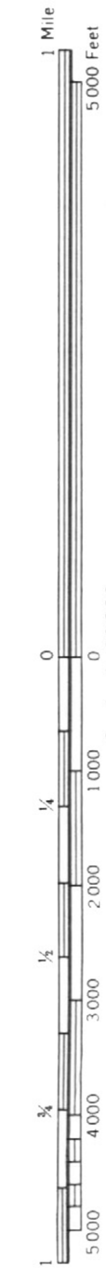

2 780 000 FEET
DRAIN NO. 1
R. 52 W.
R. 51 W.
(Joins sheet 15)
N
415 000 FEET
T. 153 N.
(Joins sheet 22)
(Joins sheet 24)
DRAIN NO. 32
1 Mile
5000 Feet
Scale 1:20000
3
2
1
6
5
10
11
12
7
8
15
14
13
18
17
33
int
(Joins sheet 32)
2 800 000 FEET
405 000 FEET

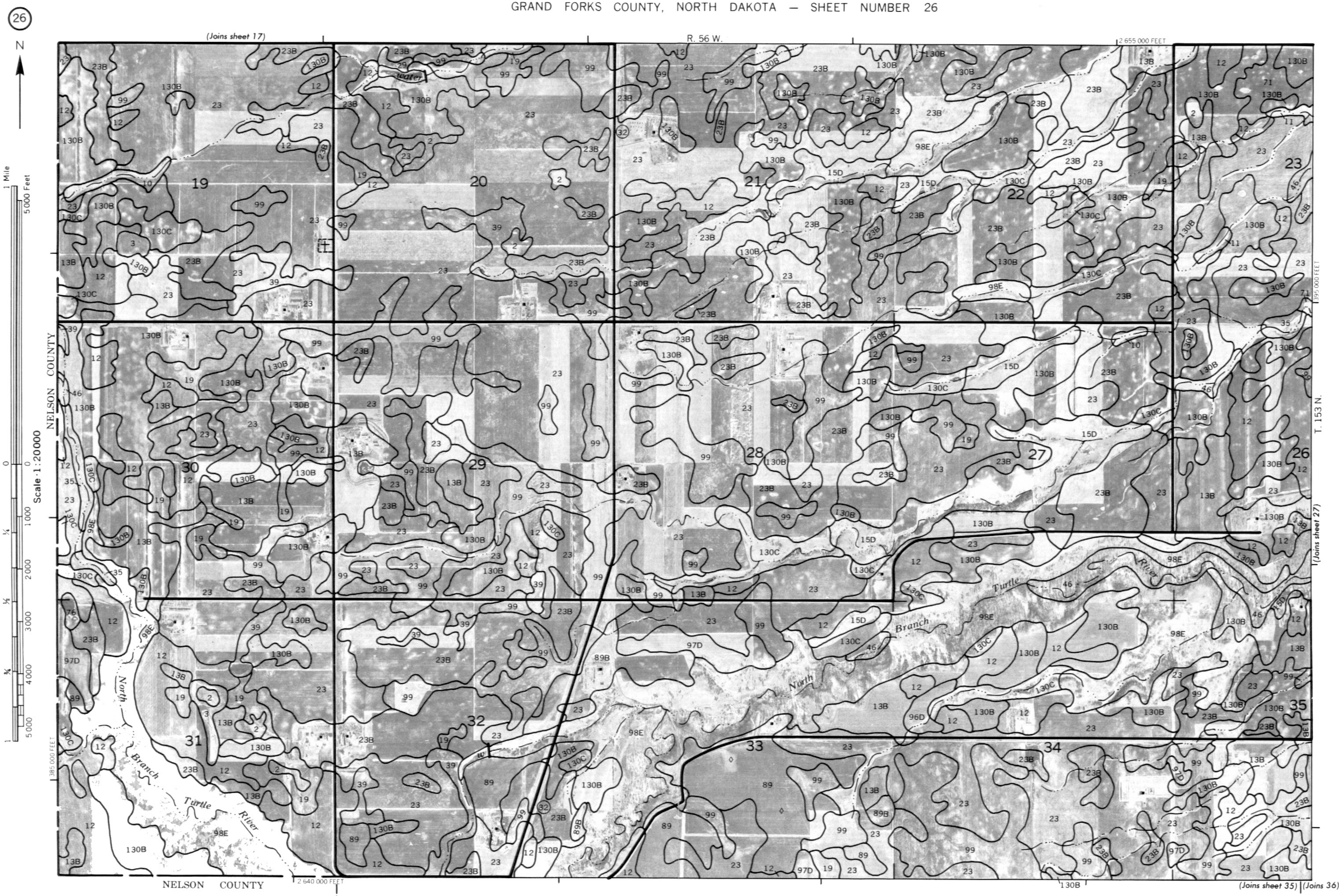

(Joins sheet 16)
R. 51 W.
2 820 000 FEET
(Joins sheet 23)
(Joins sheet 25)
T. 153 N.
420 000 FEET
(Joins sheet 33)
2 805 000 FEET
405 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
BURLINGTON NORTHERN
DRAIN NO. 32
Turtle River
South Marais River
Manvel
LAGOON
water
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

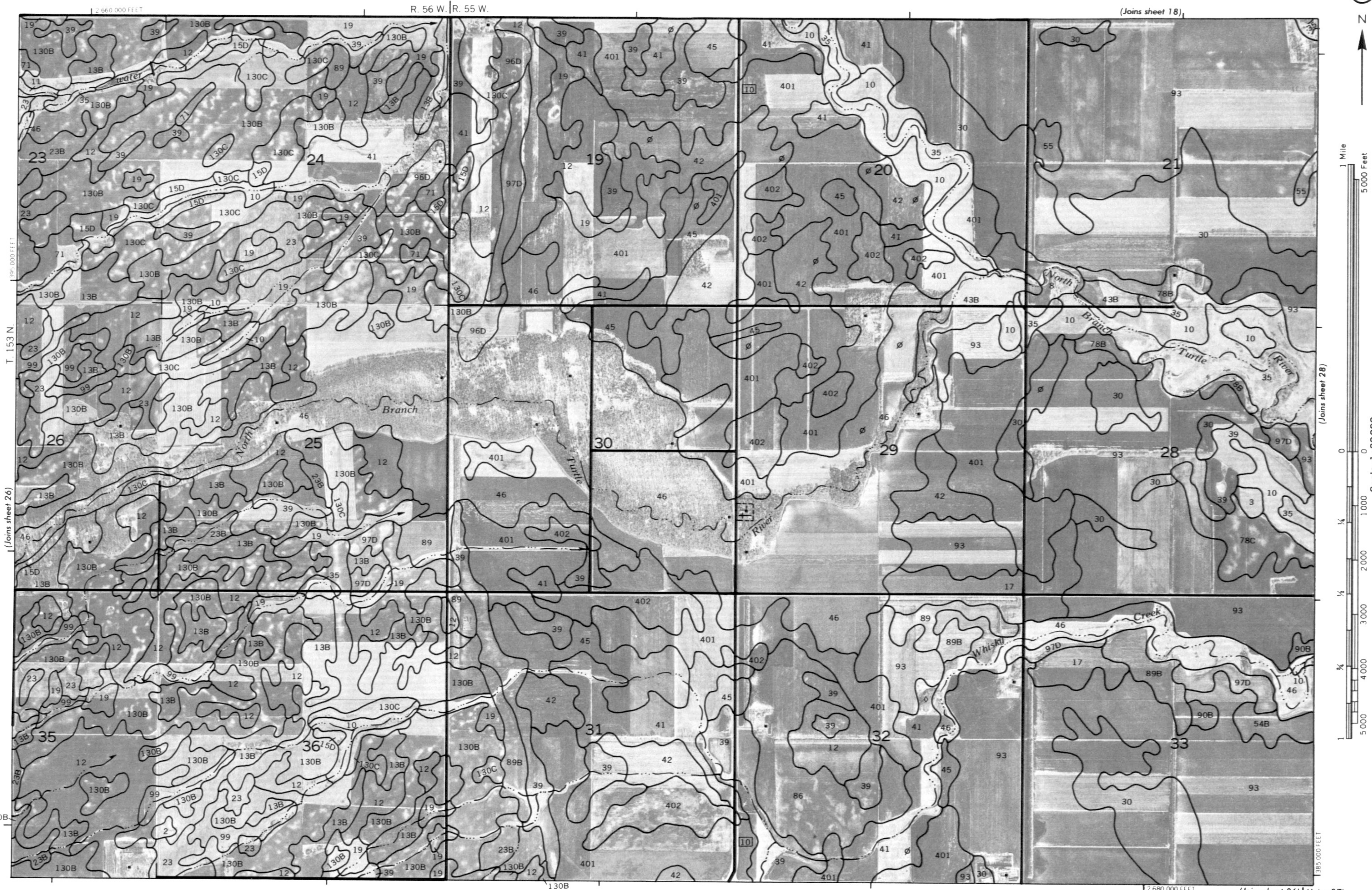
N


2 825 000 FEET
(Joins inset B, sheet 111)
R. 50 W.
T. 153 N.
(Joins sheet 24)
RED
RIVER
OF
THE
NORTH
POLK COUNTY, MINNESOTA
South Marais
River
6
7
18
17
43E
43B
45
41
11
79B
126
(Joins sheet 34)
2 830 000 FEET

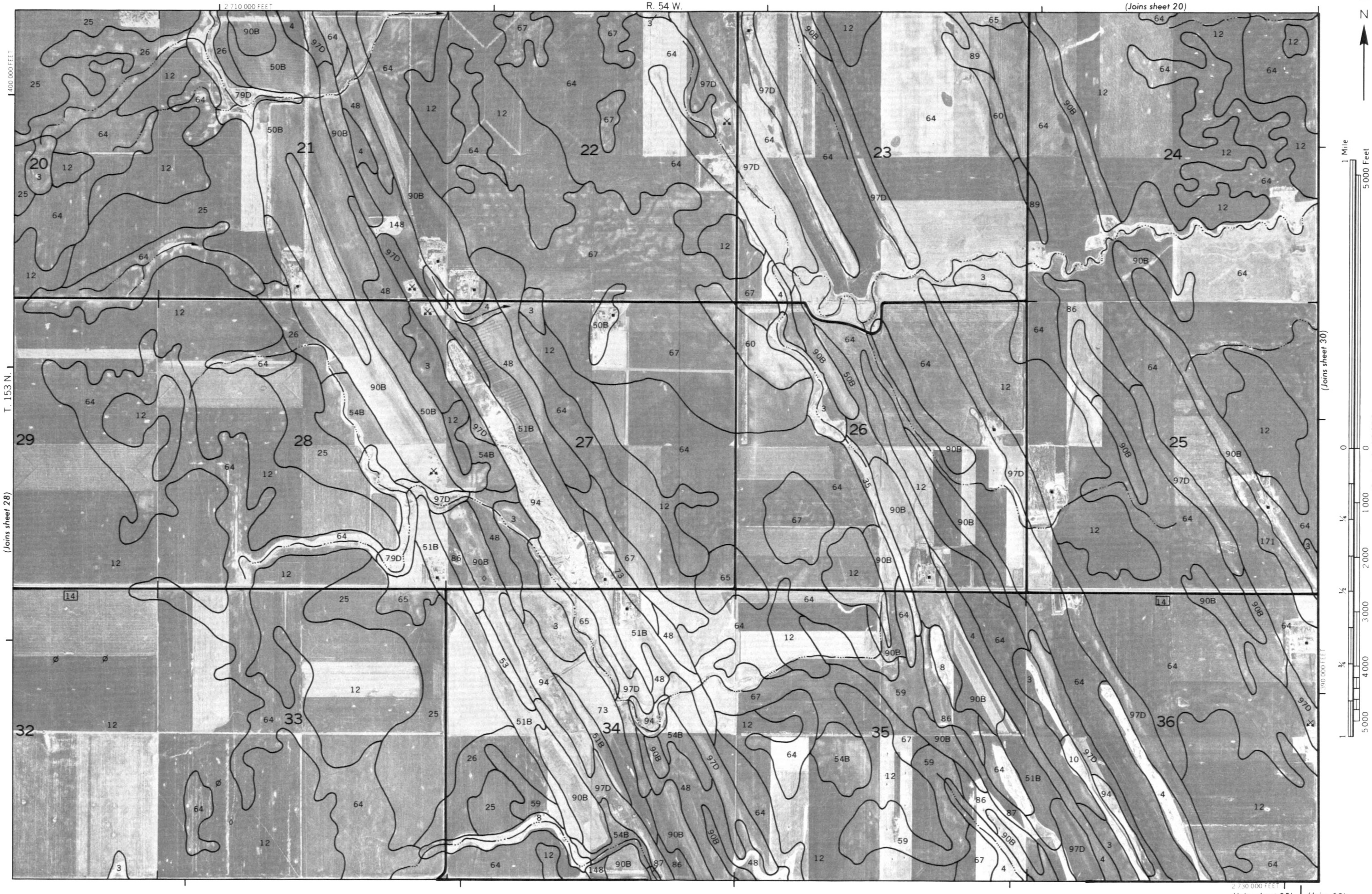

2 850 000 FEET
(Joins inset, sheet 34)
R. 50 W.
GRAND
FORKS
(county seat)
T. 151 N.
(Joins sheet 70)
RED
RIVER
OF
THE
NORTH
POLK COUNTY, MINNESOTA
Cole Creek
17
8
22
27
26
34
35
126
79C
43B
46
79B
79D
10
25
43E
(Joins sheet 80)
2 860 000 FEET

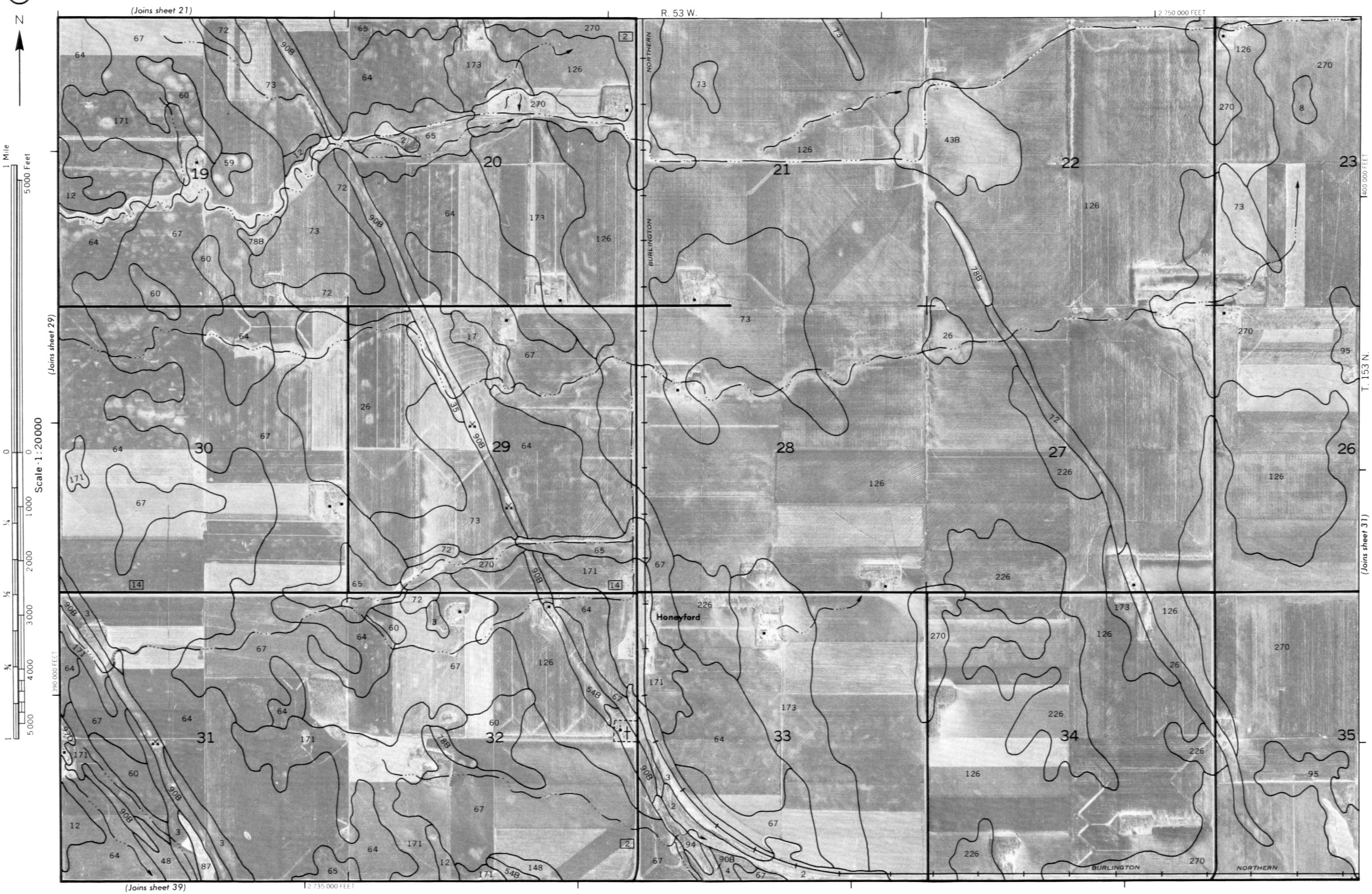

1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
Scale 1:20000


26
N
(Joins sheet 17)
R. 56 W.
2 655 000 FEET
395 000 FEET
T. 153 N.
(Joins sheet 27)
NELSON COUNTY
2 640 000 FEET
385 000 FEET
(Joins sheet 35)
(Joins 36)
1 Mile
5000 Feet
Scale 1:20000
North Branch Turtle River
water


R. 56 W. | R. 55 W.
2 660 000 FEET
(Joins sheet 18)
N
T. 153 N.
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 36)
(Joins 37)
2 680 000 FEET
385 000 FEET
North Branch Turtle River
Whiskey Creek
Scale 1:20 000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

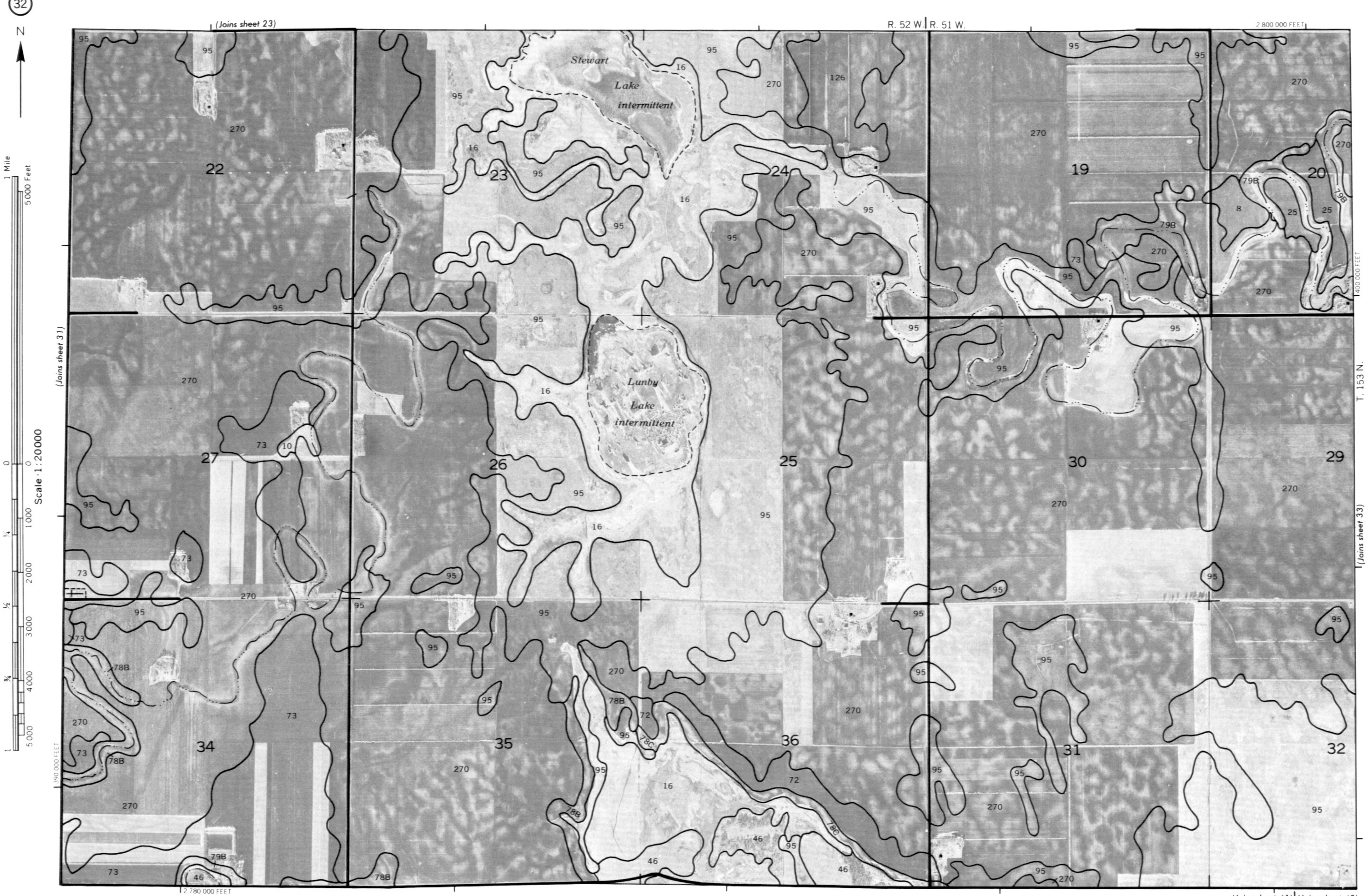

28
N
(Joins sheet 19)
R. 55 W.
R. 54 W.
2 705 000 FEET
400 000 FEET
T. 153 N.
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 37)
(Joins 38)
2 685 000 FEET
385 000 FEET
1 Mile
5000 Feet
Scale 1:20000
NORTHERN
BURLINGTON
North
Branch
Turtle
River
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32

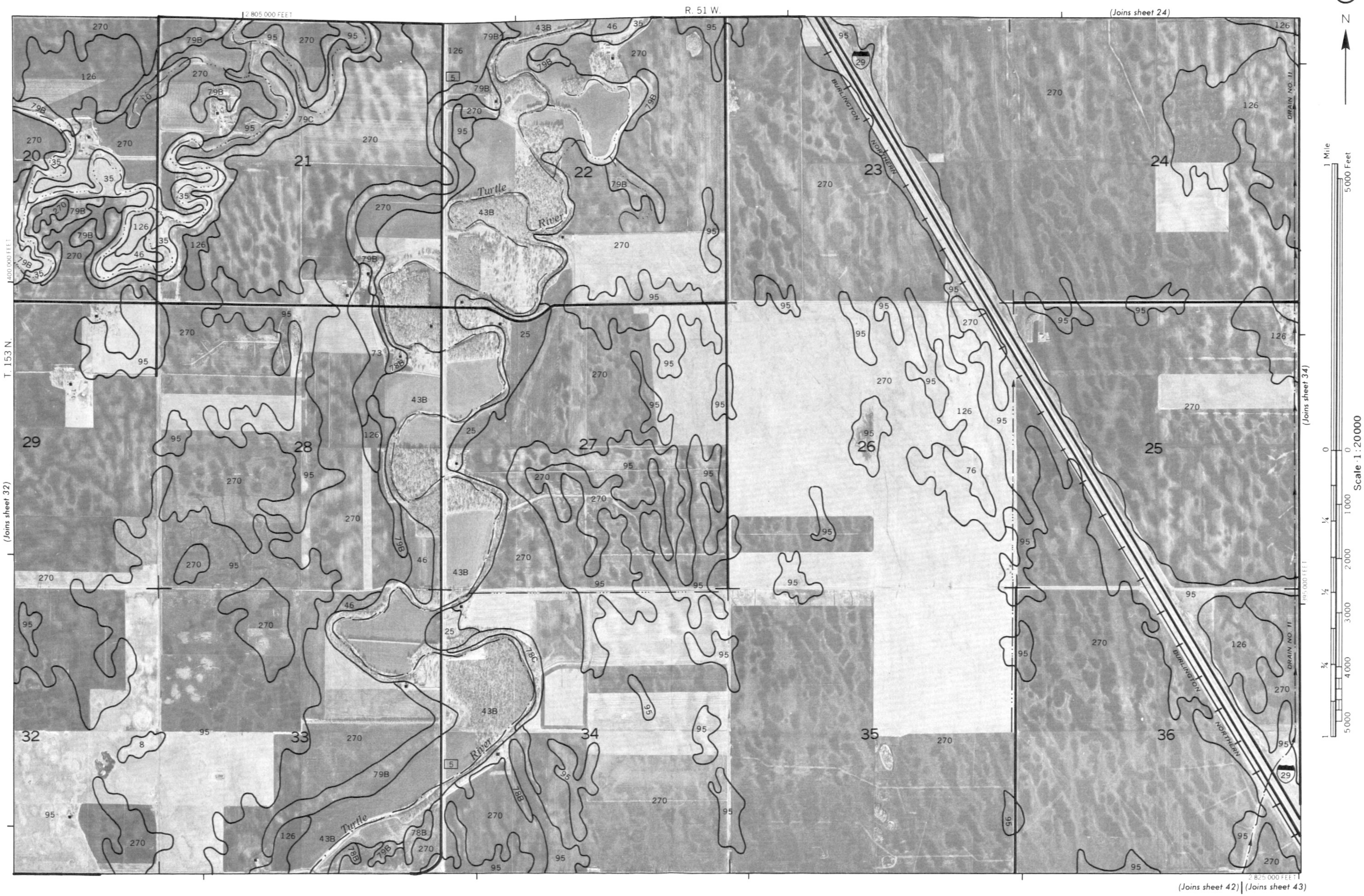

29
N
2 710 000 FEET
R. 54 W.
(Joins sheet 20)
400 000 FEET
T. 153 N.
(Joins sheet 28)
(Joins sheet 30)
2 730 000 FEET
(Joins sheet 38)
(Joins 39)
390 000 FEET
1 Mile
5000 Feet
Scale 1:20000
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
14

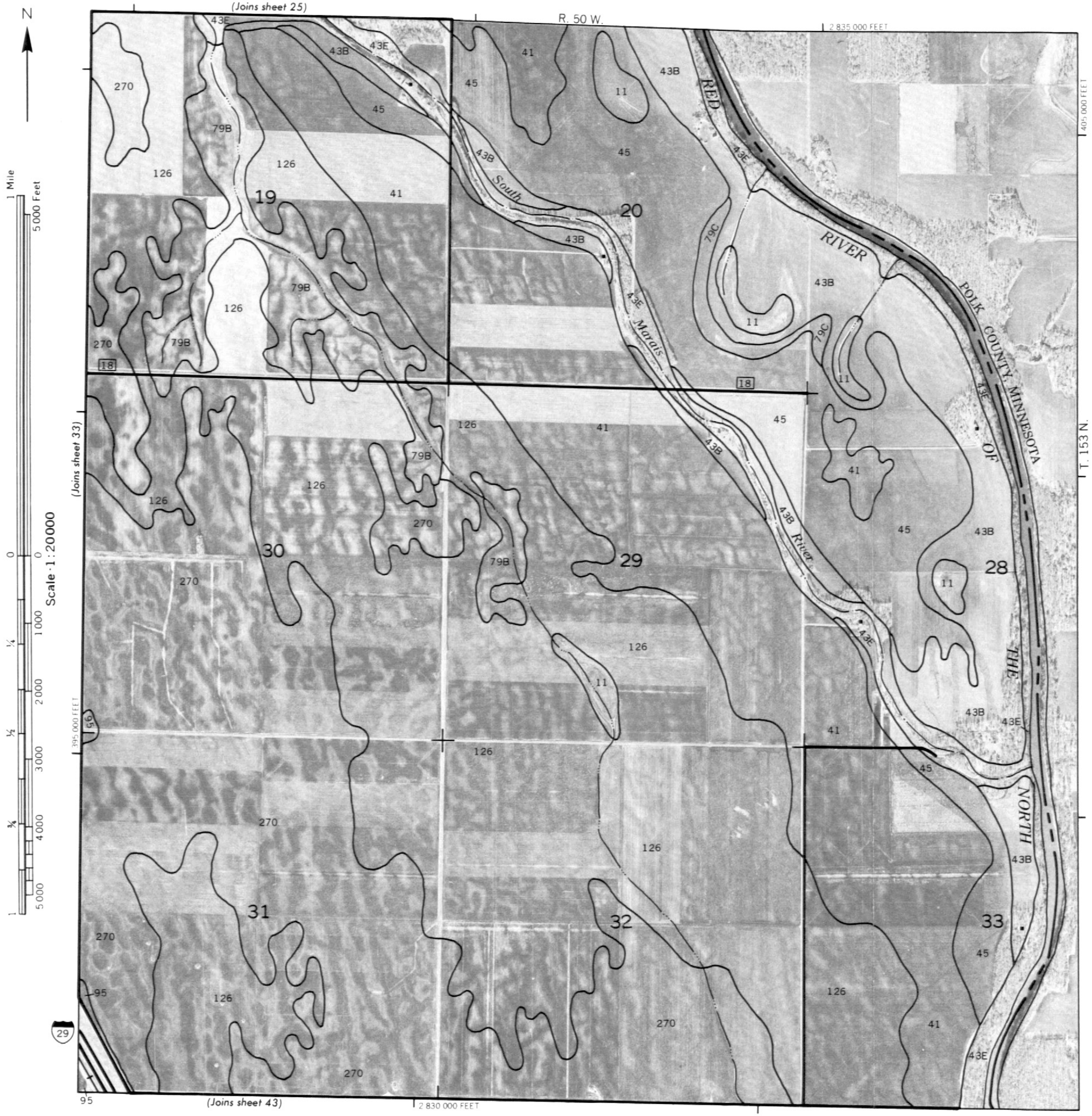

30
N
(Joins sheet 21)
R. 53 W.
2 750 000 FEET
400 000 FEET
T. 153 N.
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 39)
2 735 000 FEET
390 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
NORTHERN
BURLINGTON
Honeyford
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35


31
N
R. 53 W.
R. 52 W.
(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 40)
(Joins sheet 41)
T. 153 N.
2 755 000 FEET
400 000 FEET
390 000 FEET
2 775 000 FEET
DRAIN NO. 12
BURLINGTON NORTHERN
Turtle River
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000

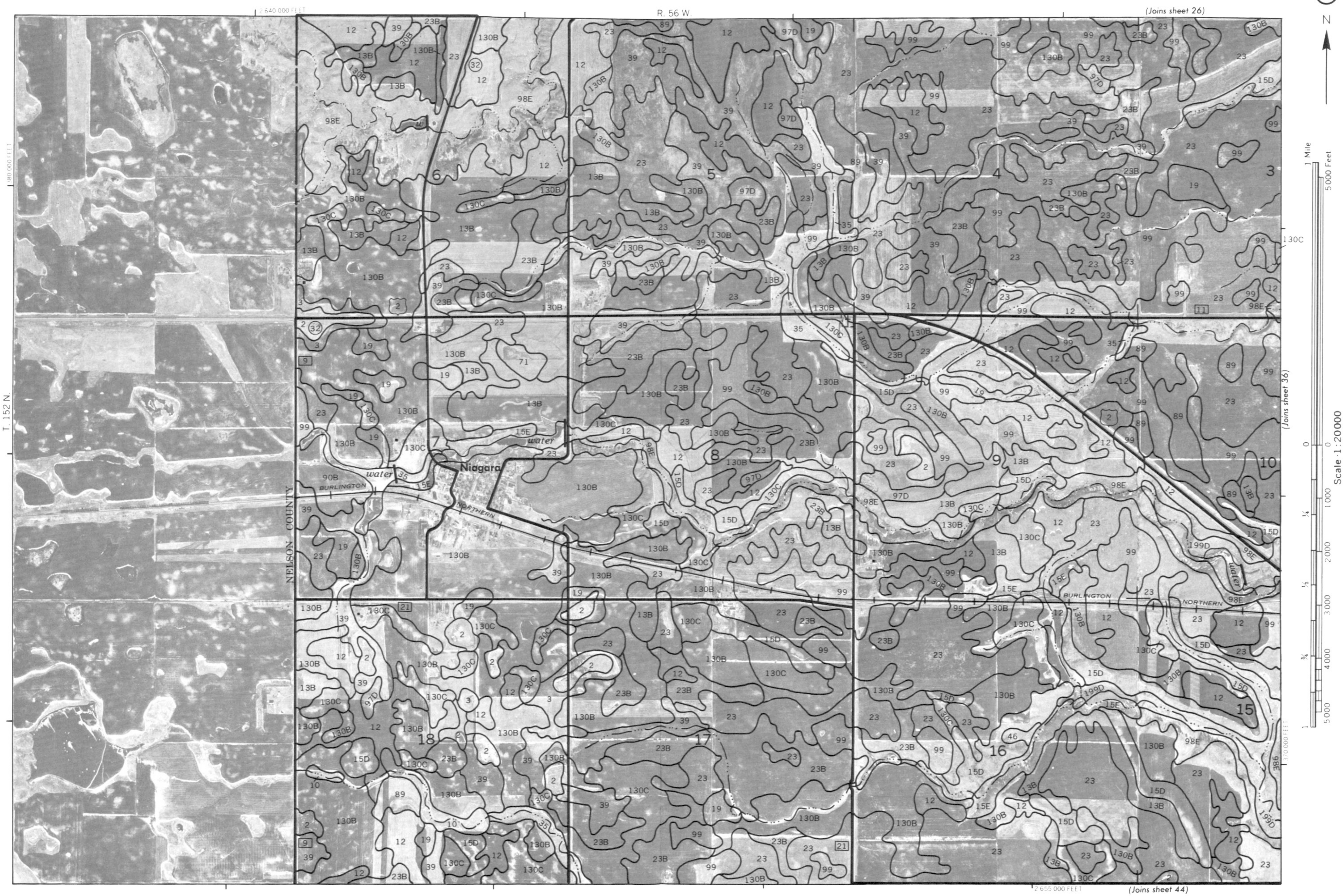
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 32




33
N
R. 51 W.
(Joins sheet 24)
(Joins sheet 34)
(Joins sheet 32)
(Joins sheet 42)
(Joins sheet 43)
T. 153 N.
2 805 000 FEET
2 825 000 FEET
400 000 FEET
395 000 FEET
Turtle River
BURLINGTON NORTHERN
DRAIN NO. 11
29
5
1 Mile
5000 Feet
Scale 1:20000
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36


N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
(Joins sheet 25)
(Joins sheet 33)
(Joins sheet 43)
R. 50 W.
T. 153 N.
2 835 000 FEET
2 830 000 FEET
405 000 FEET
395 000 FEET
19
20
28
29
30
31
32
33
RED RIVER OF THE NORTH
POLK COUNTY, MINNESOTA
South Marais River
18
29
95
11
41
43B
43E
45
79B
79C
126
270

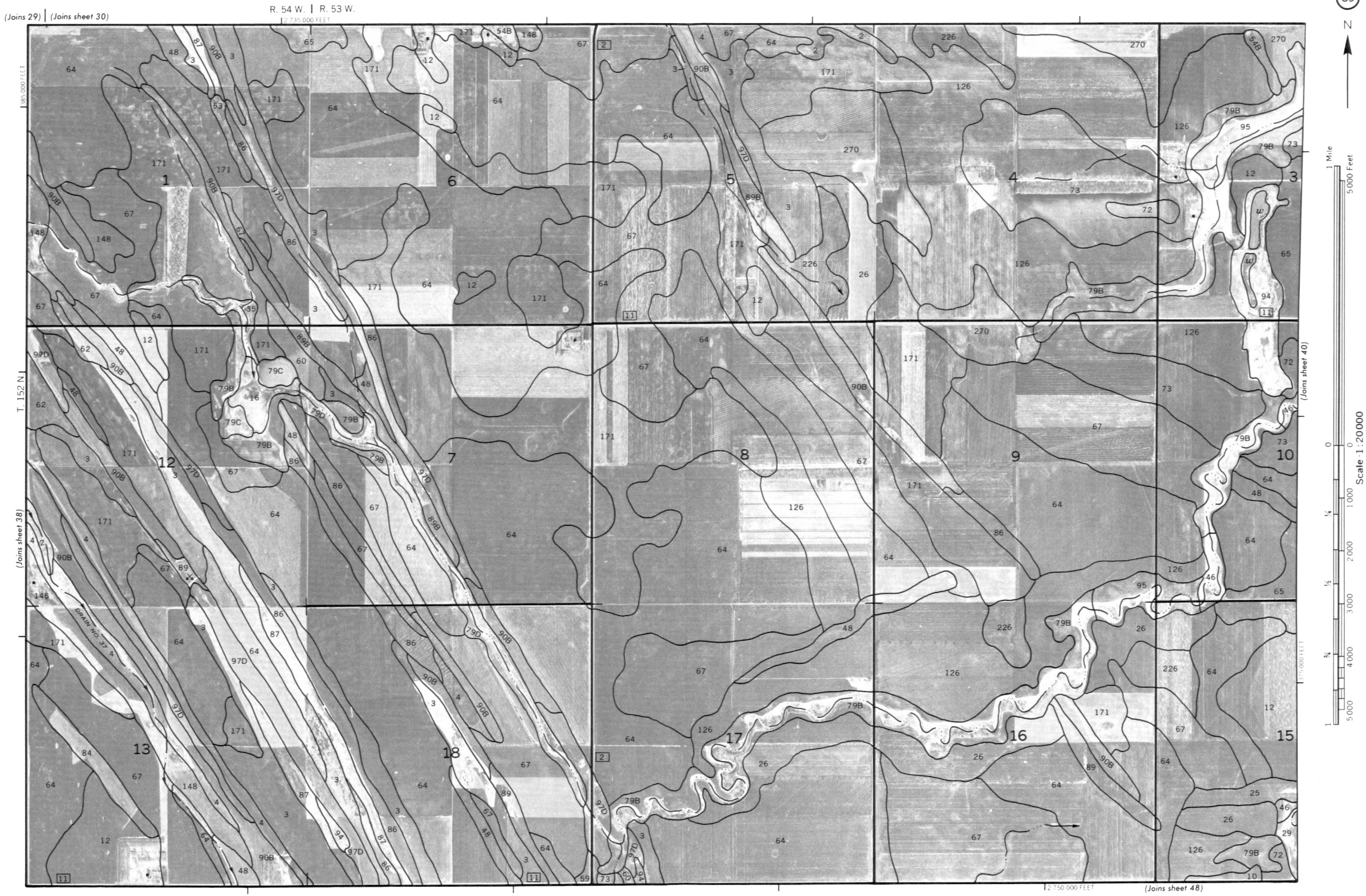

R. 50 W.
T. 151 N.
2 855 000 FEET
2 850 000 FEET
355 000 FEET
345 000 FEET
(Joins sheet 61)
(Joins inset, sheet 25)
GRAND FORKS
(county seat)
3
10
15
RED RIVER OF THE NORTH
POLK COUNTY, MINNESOTA
43B
79C
126

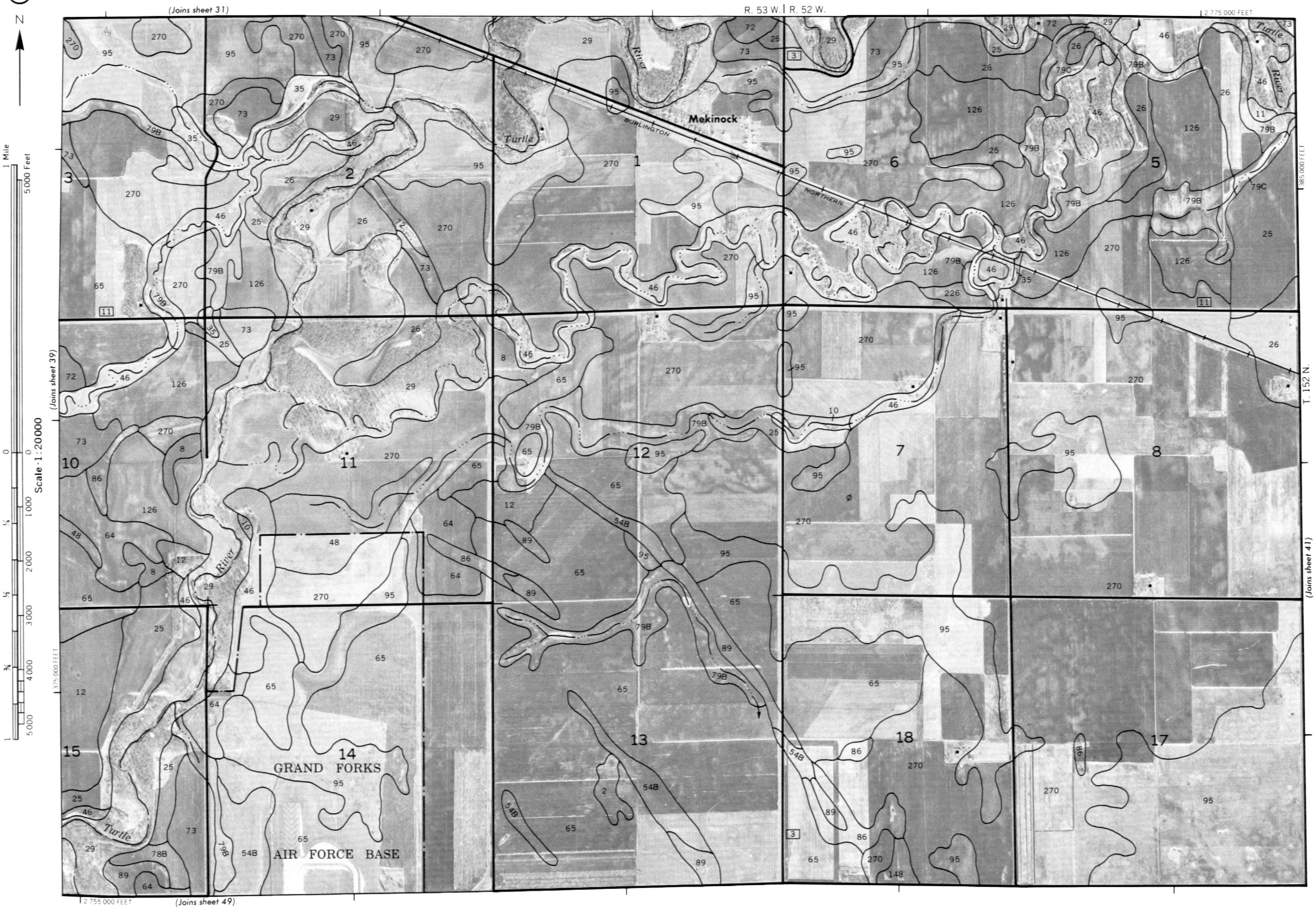

35
N
2 640 000 FEET
R. 56 W.
(Joins sheet 26)
T. 152 N.
NELSON COUNTY
Niagara
BURLINGTON
NORTHERN
water
(Joins sheet 36)
Scale 1:20000
1 Mile
5000 Feet
2 655 000 FEET
(Joins sheet 44)

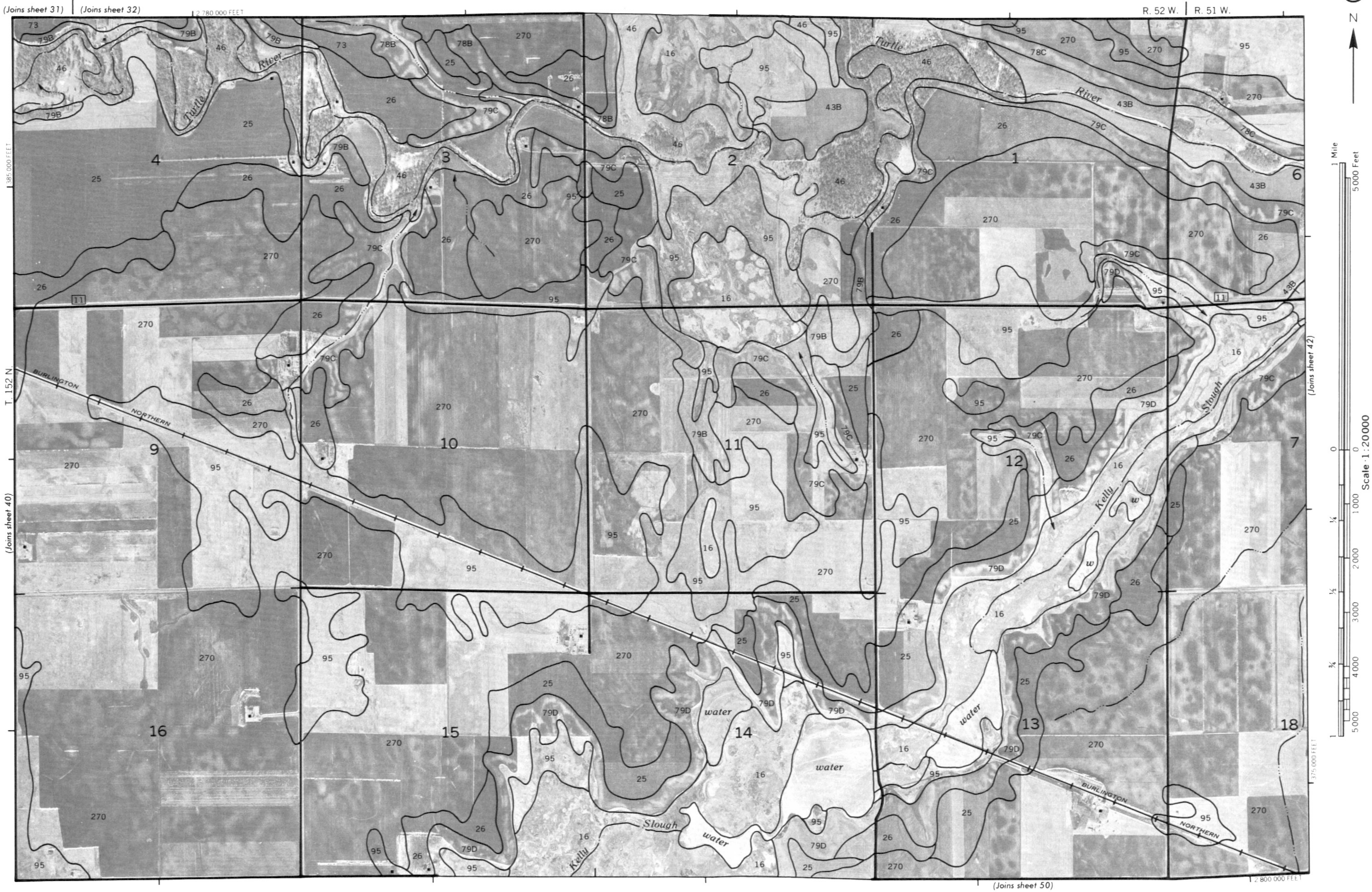
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 36


37
(Joins 27)
(Joins sheet 28)
2 685 000 FEET
R. 55 W.
R. 54 W.
N
(Joins sheet 38)
(Joins sheet 36)
(Joins sheet 46)
2 705 000 FEET
380 000 FEET
T. 152 N.
McCanna
BURLINGTON
NORTHERN
North Branch
Turtle River
1 Mile
5000 Feet
Scale 1:20000

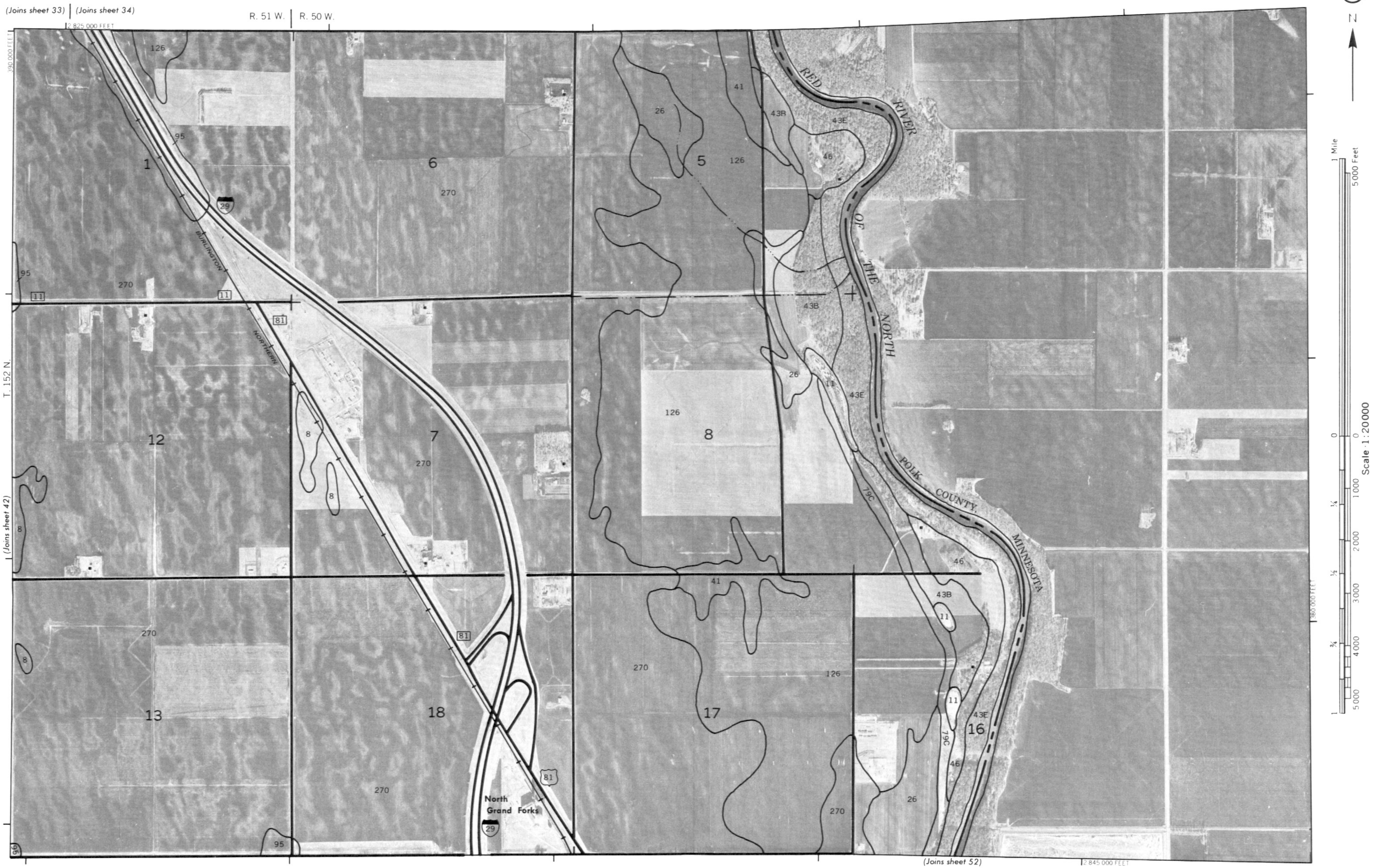
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 38

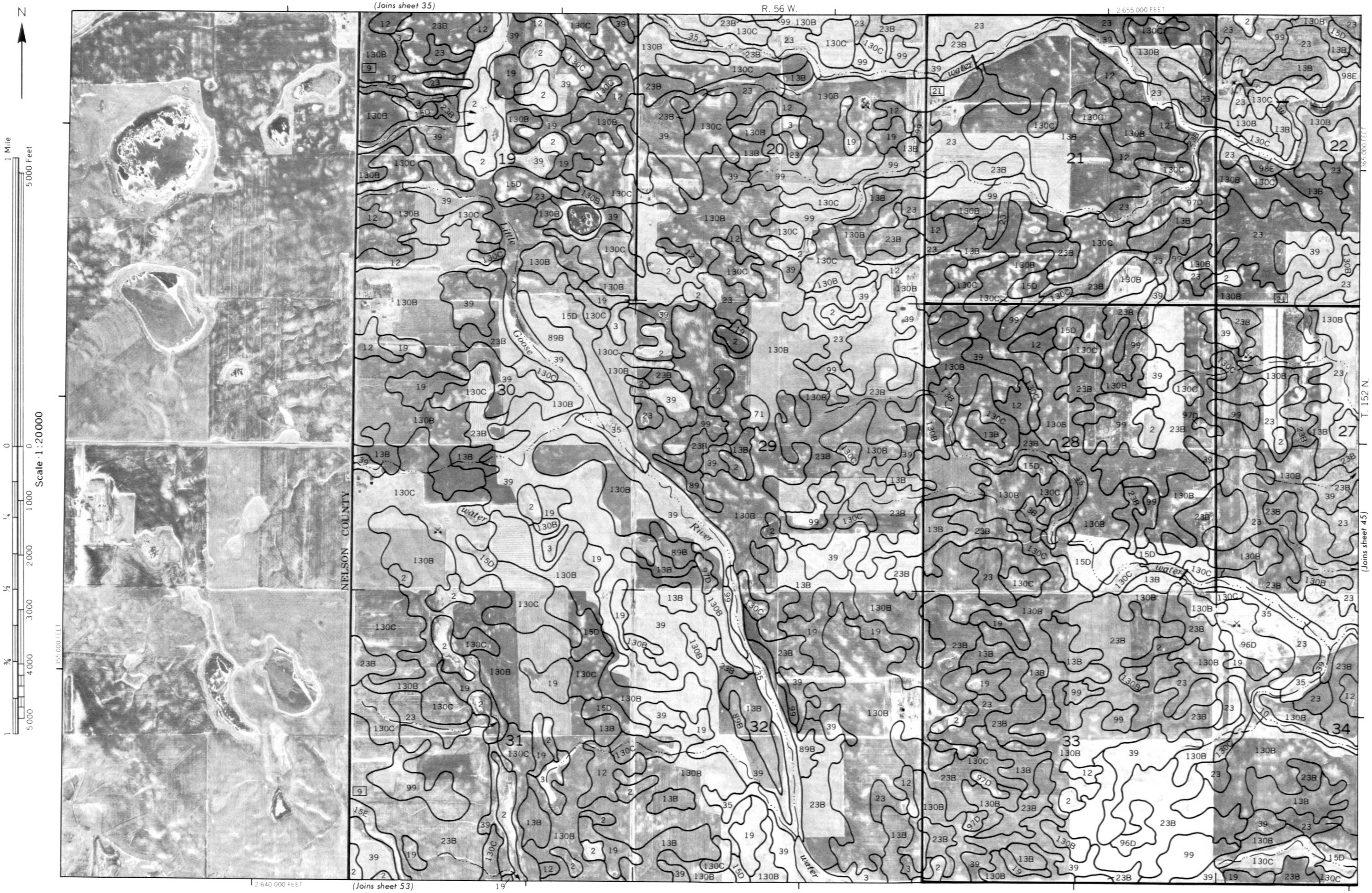

(Joins 29)
(Joins sheet 30)
R. 54 W.
R. 53 W.
2 735 000 FEET
185 000 FEET
T. 152 N.
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 48)
2 750 000 FEET
175 000 FEET
DRAIN NO 37
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
(Joins sheet 31)
R. 53 W. | R. 52 W.
2 775 000 FEET
385 000 FEET
T. 152 N.
(Joins sheet 41)
(Joins sheet 39)
(Joins sheet 49)
2 755 000 FEET
375 000 FEET
1 Mile
5000 Feet
Scale 1:20000
Mekinock
BURLINGTON
NORTHERN
Turtle
River
Turtle River
GRAND FORKS
AIR FORCE BASE
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18

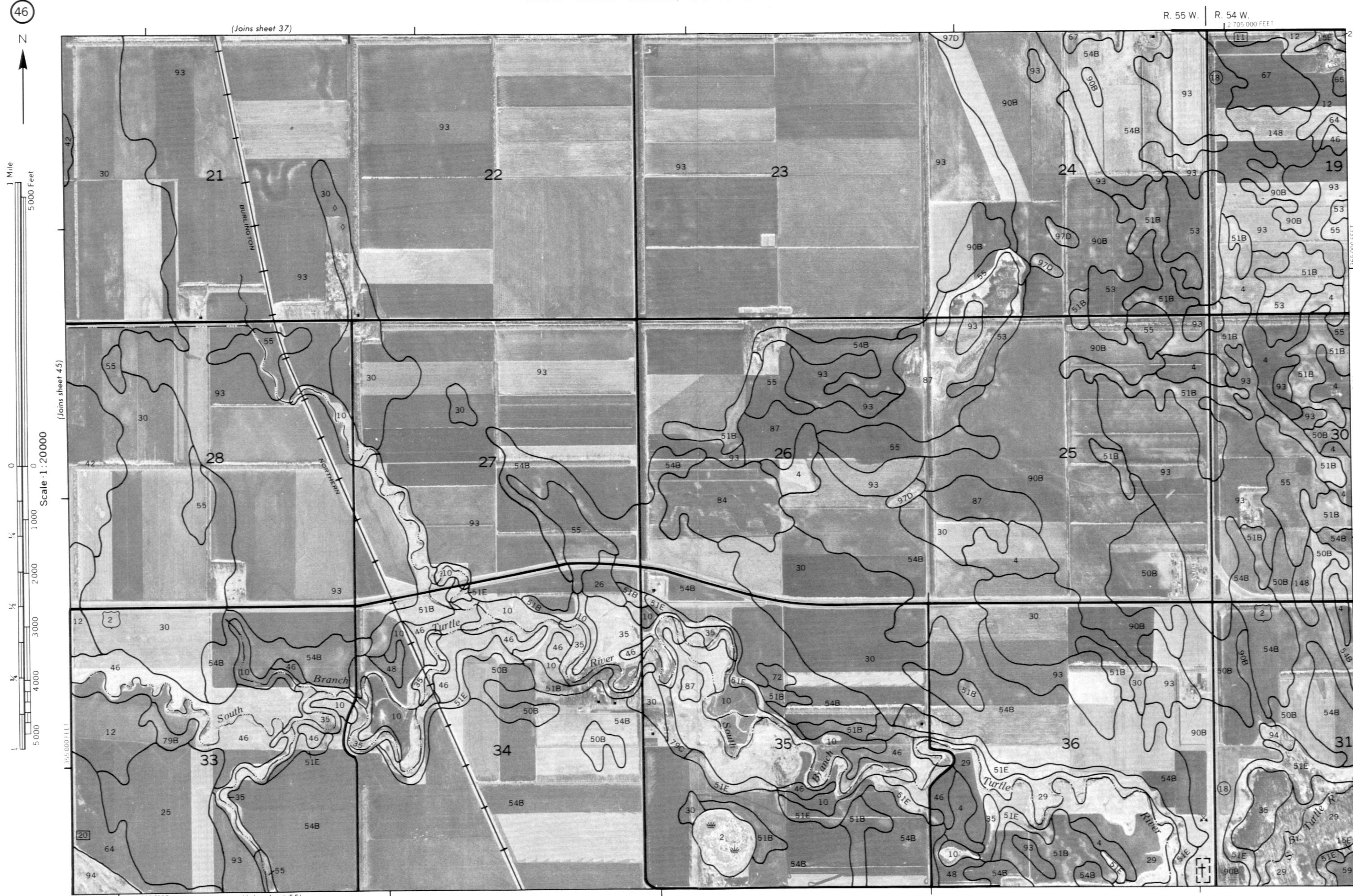

(Joins sheet 31)
(Joins sheet 32)
2 780 000 FEET
R. 52 W.
R. 51 W.
N
Turtle River
Turtle River
Kelly Slough
Kelly Slough
BURLINGTON NORTHERN
BURLINGTON NORTHERN
T. 152 N.
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 50)
385 000 FEET
375 000 FEET
2 800 000 FEET
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18
water
w
11
1 Mile
5000 Feet
0
1/4
1/2
3/4
1000
2000
3000
4000
5000
Scale 1:20000


N
(Joins sheet 32)
(Joins sheet 33)
R. 51 W.
2 820 000 FEET
390 000 FEET
DRAIN NO. 11
DRAIN NO. 39
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 51)
2 805 000 FEET
375 000 FEET
T. 152 N.
1 Mile
5 000 Feet
Scale 1:20000
Turtle
River
Kelly
Slough
Salt
Water
Coulee
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18
95
270
43B
79B
79C
78C
78B
73
126
25
226
79D
5
11


(Joins sheet 33) | (Joins sheet 34)
R. 51 W. | R. 50 W.
T. 152 N.
(Joins sheet 42)
(Joins sheet 52)
RED RIVER OF THE NORTH
POLK COUNTY, MINNESOTA
BURLINGTON NORTHERN
North Grand Forks
43
N
Scale 1:20 000
1 Mile
5000 Feet


N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
(Joins sheet 35)
R. 56 W.
2 655 000 FEET
355 000 FEET
T. 152 N.
(Joins sheet 45)
(Joins sheet 53)
2 640 000 FEET
NELSON COUNTY
Little
Goose
River
water
19
20
21
22
27
28
29
30
31
32
33
34


N
R. 56 W.
R. 55 W.
T. 152 N.
(Joins sheet 36)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 54)
2 660 000 FEET
2 680 000 FEET
Whisky Creek
South Branch
Turtle River
Burlington Northern
water
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 Mile
5000 Feet
Scale 1:20000

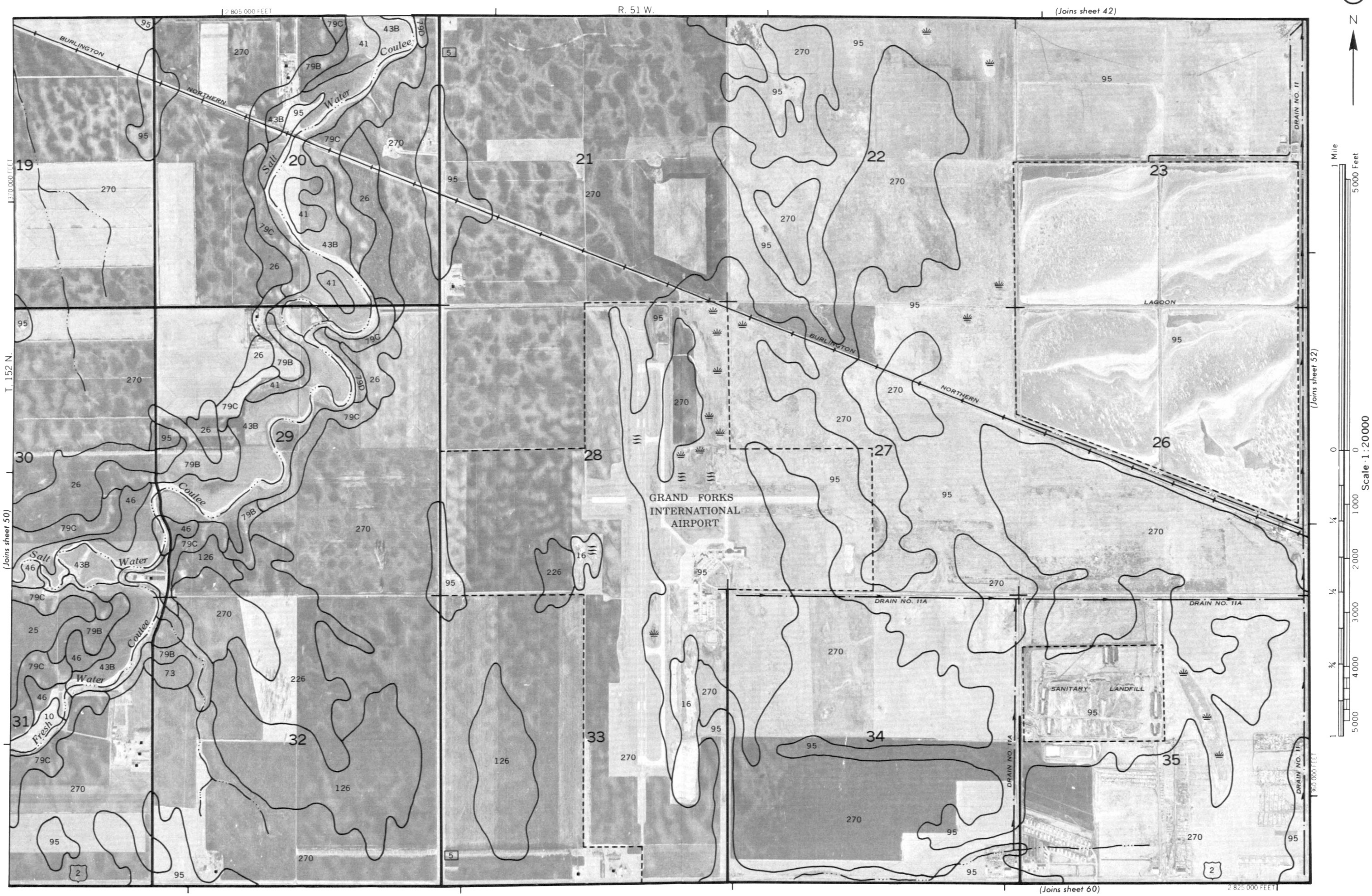

46
N
(Joins sheet 37)
(Joins sheet 45)
(Joins sheet 47)
(Joins sheet 55)
R. 55 W.
R. 54 W.
T. 152 N.
2 705 000 FEET
2 685 000 FEET
365 000 FEET
1 Mile
5000 Feet
Scale 1:20000
BURLINGTON
NORTHERN
Turtle
River
South
Branch
St. Turtle R.
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
2
18
20
11


2 710 000 FEET
R. 54 W.
(Joins sheet 38)
T. 152 N.
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 56)
2 730 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
North Branch Turtle River
South Branch Turtle River
Turtle River


N
(Joins sheet 39)
R. 54 W. | R. 53 W.
2 750 000 FEET
370 000 FEET
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 57)
2 735 000 FEET
355 000 FEET
T. 152 N.
1 Mile
5000 Feet
Scale 1:20000
GRAND FORKS AIR FORCE BASE
TURTLE RIVER STATE PARK
Turtle River
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

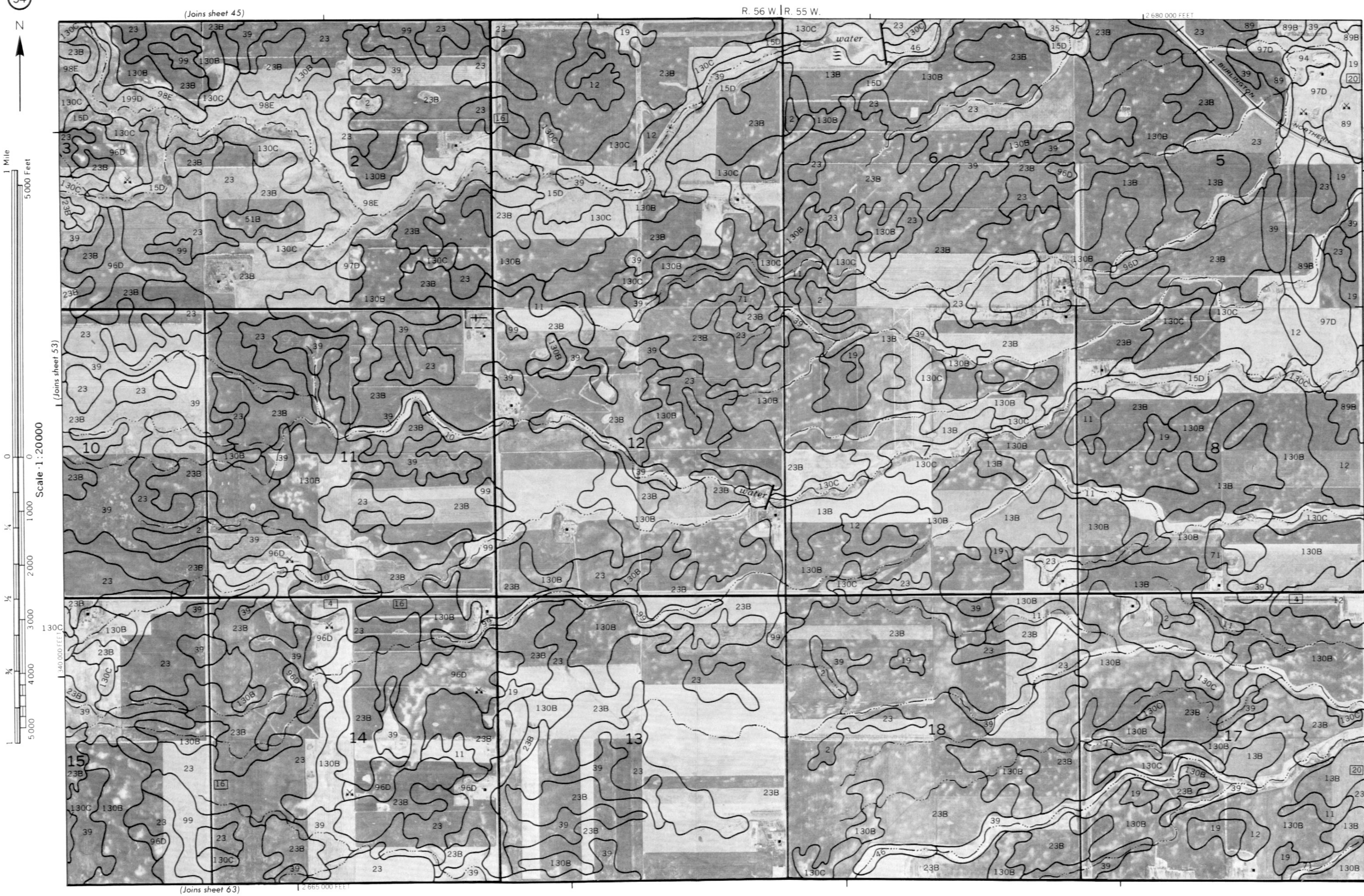

R. 53 W.
R. 52 W.
(Joins sheet 40)
(Joins sheet 48)
(Joins sheet 50)
(Joins sheet 58)
2 755 000 FEET
370 000 FEET
2 775 000 FEET
350 000 FEET
T. 152 N.
N
1 Mile
5 000 Feet
Scale 1:20000
GRAND FORKS AIR FORCE BASE
Turtle River
Kelly Slough
LAGOON
NORTHERN
BURLINGTON
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32

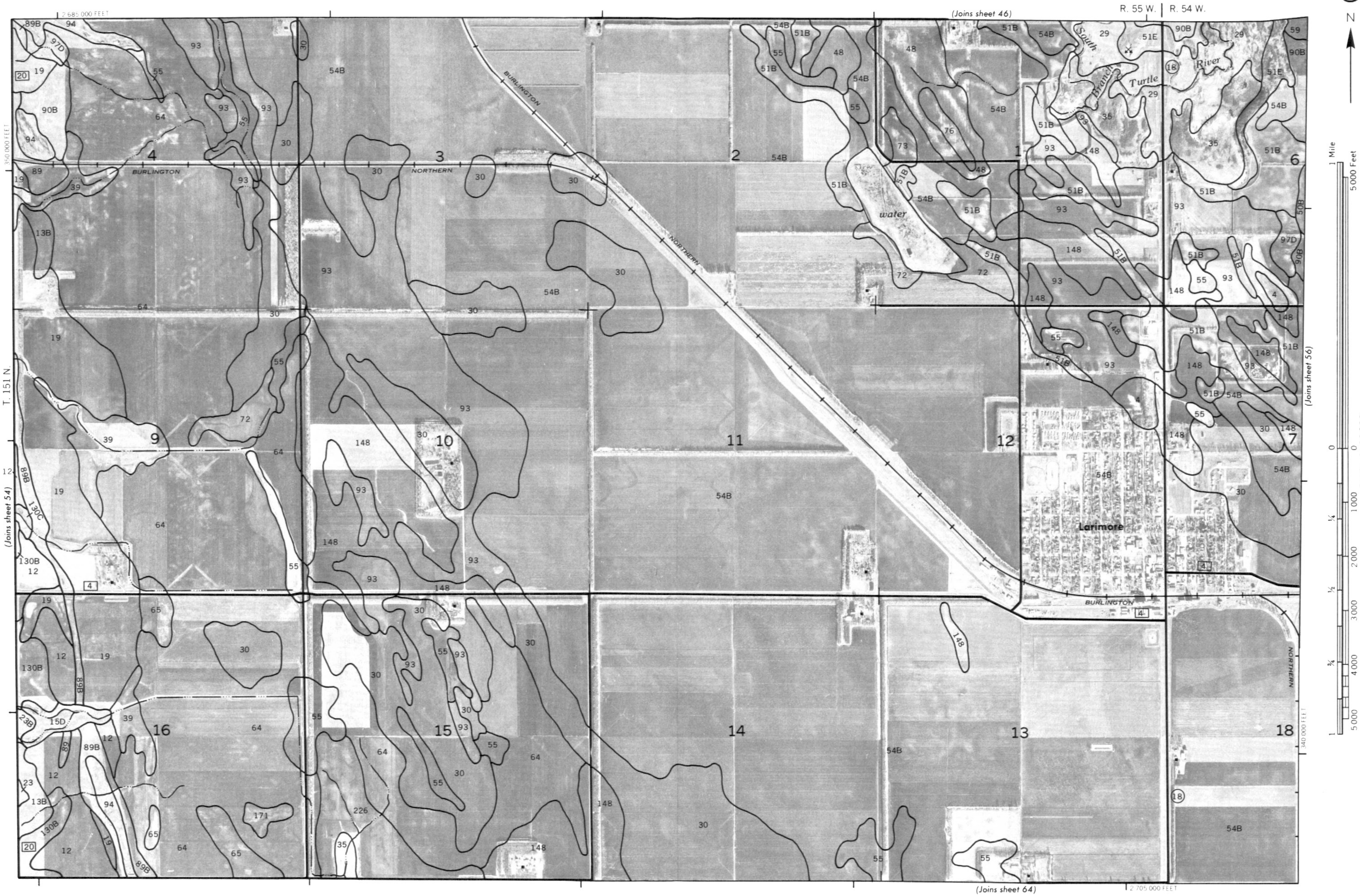

N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 41)
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 59)
R. 52 W.
R. 51 W.
T. 152 N.
2 800 000 FEET
2 780 000 FEET
370 000 FEET
360 000 FEET
Kelly Slough
water
Coulee
Salt Water
Fresh Water
Coulee
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31


R. 51 W.
(Joins sheet 42)
(Joins sheet 50)
(Joins sheet 52)
(Joins sheet 60)
T. 152 N.
2 805 000 FEET
2 825 000 FEET
N
BURLINGTON NORTHERN
Salt Water Coulee
Fresh Water
GRAND FORKS INTERNATIONAL AIRPORT
LAGOON
SANITARY LANDFILL
DRAIN NO. 11A
DRAIN NO. 11
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Scale 1:20000
1 Mile
5000 Feet


(Joins sheet 43)
R. 51 W. | R. 50 W.
(Joins sheet 51)
(Joins sheet 61)
T. 152 N.
N
Scale 1:20000
1 Mile
5 000 Feet
2 845 000 FEET
2 830 000 FEET
360 000 FEET
24
19
20
25
30
29
28
36
31
32
33
ENGLISH COULEE DIVERSION
BURLINGTON NORTHERN
LAGOON
POLK COUNTY, MINNESOTA
RED RIVER OF THE NORTH
English Coulee
GRAND FORKS
(county seat)
270
95
126
43E
43B
46
79B
79C
79D


53
N
R. 56 W.
T. 151 N.
2 640 000 FEET
2 660 000 FEET
(Joins sheet 44)
(Joins sheet 54)
(Joins sheet 62)
NELSON COUNTY
Smith Lakes
Smith Lakes
Little Goose River
Little Goose River
water
Scale 1:20000
1 Mile
5000 Feet


N
(Joins sheet 45)
R. 56 W.
R. 55 W.
2 680 000 FEET
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 63)
T. 151 N.
2 665 000 FEET
water
BURLINGTON NORTHERN



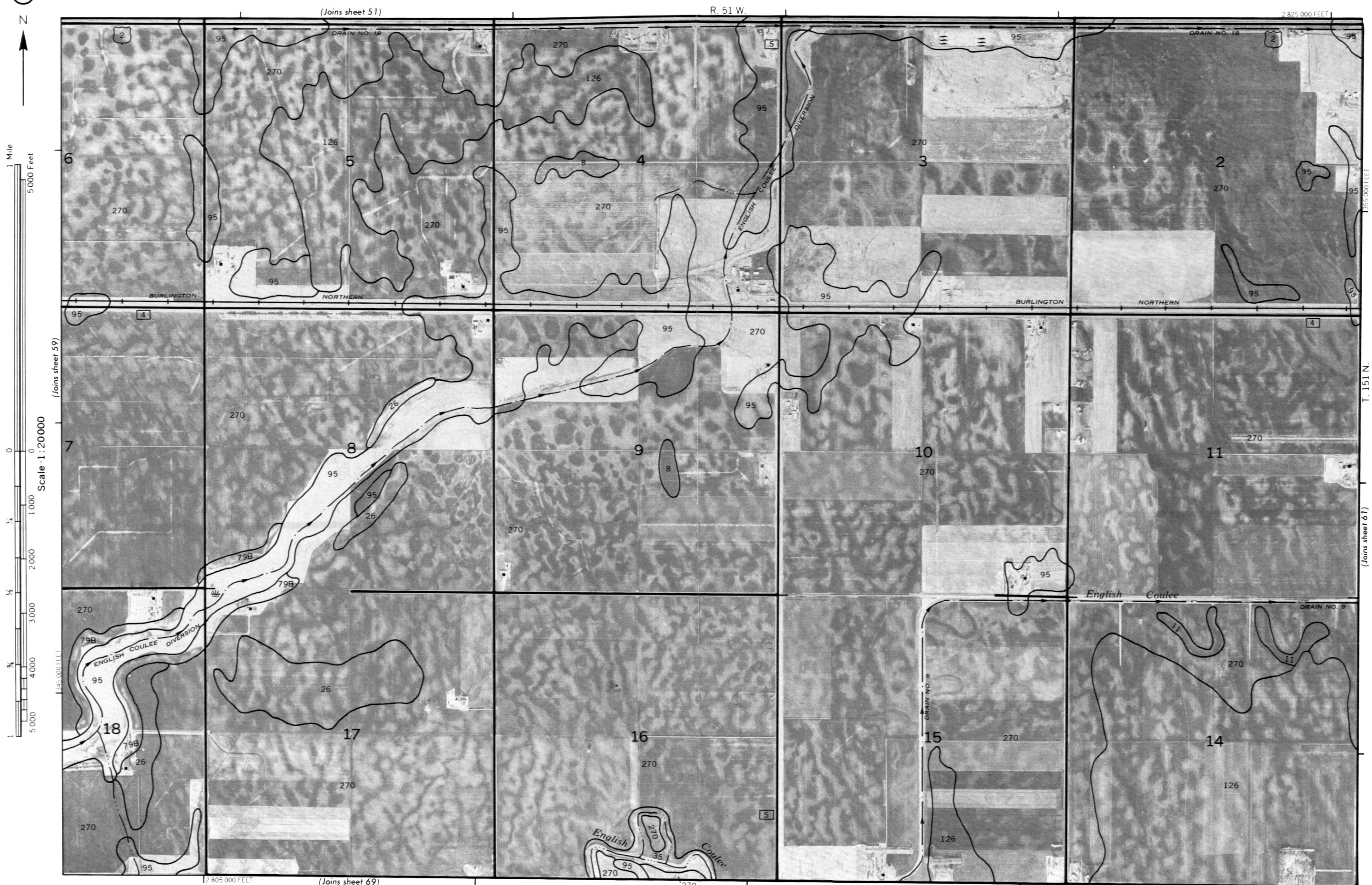
55
N
(Joins sheet 46)
R. 55 W.
R. 54 W.
2 685 000 FEET
350 000 FEET
T. 151 N.
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 64)
2 705 000 FEET
340 000 FEET
BURLINGTON
NORTHERN
South Branch Turtle River
water
Larimore
1 Mile
5000 Feet
Scale 1:20000


56
N
(Joins sheet 47)
R. 54 W.
2 730 000 FEET
350 000 FEET
T. 151 N.
(Joins sheet 55)
(Joins sheet 57)
(Joins sheet 65)
2 710 000 FEET
140 000 FEET
Scale 1:20000
1 Mile
5000 Feet
BURLINGTON
NORTHERN
DRAIN NO. 42
Turtle
River
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18

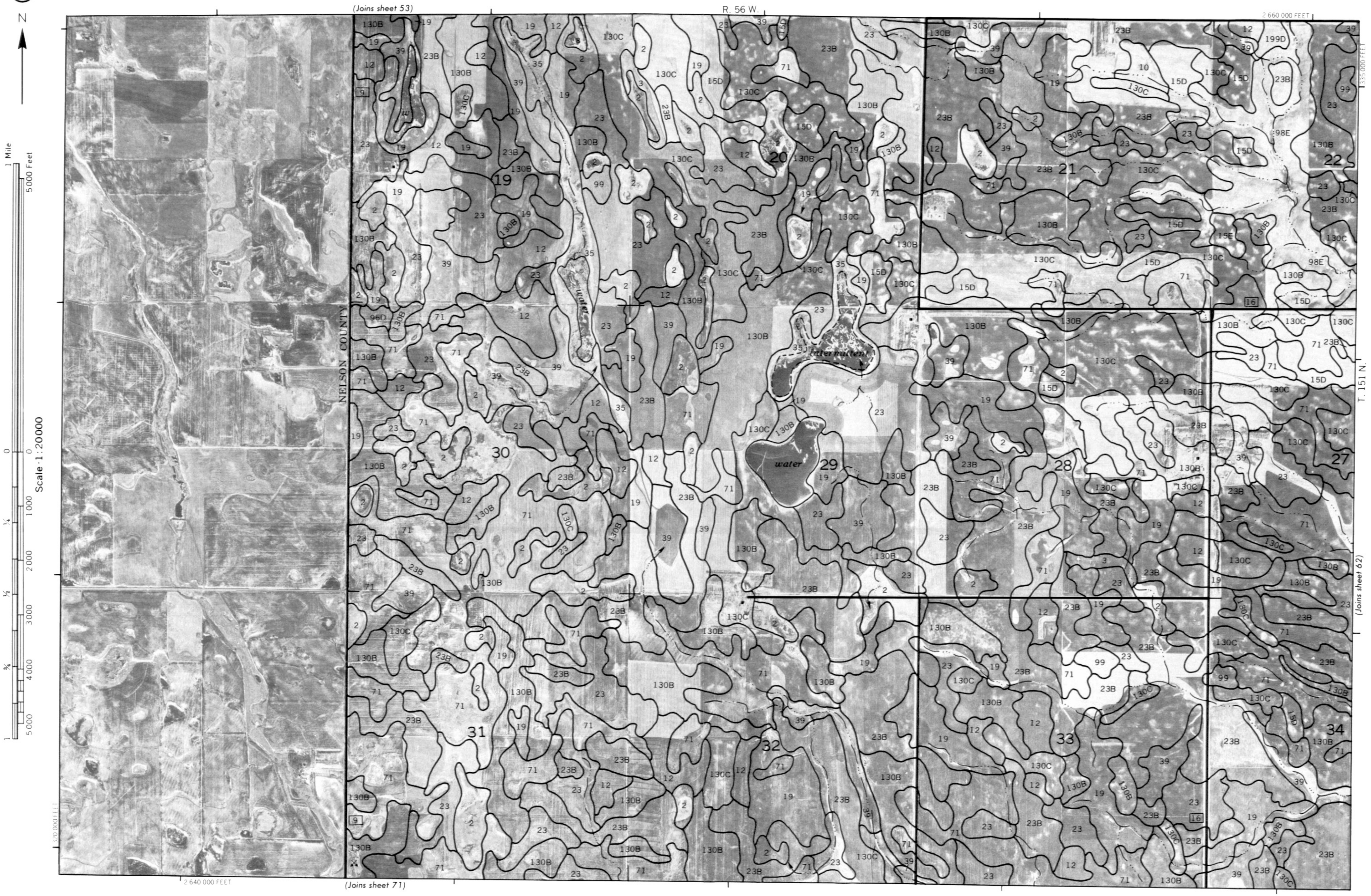

2 735 000 FEET
R. 54 W.
R. 53 W.
(Joins sheet 48)
(Joins sheet 56)
(Joins sheet 58)
(Joins sheet 66)
2 755 000 FEET
340 000 FEET
T. 151 N.
Arvilla
BURLINGTON
NORTHERN
Hazen
Brook
N
1 Mile
5000 Feet
Scale 1:20000
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

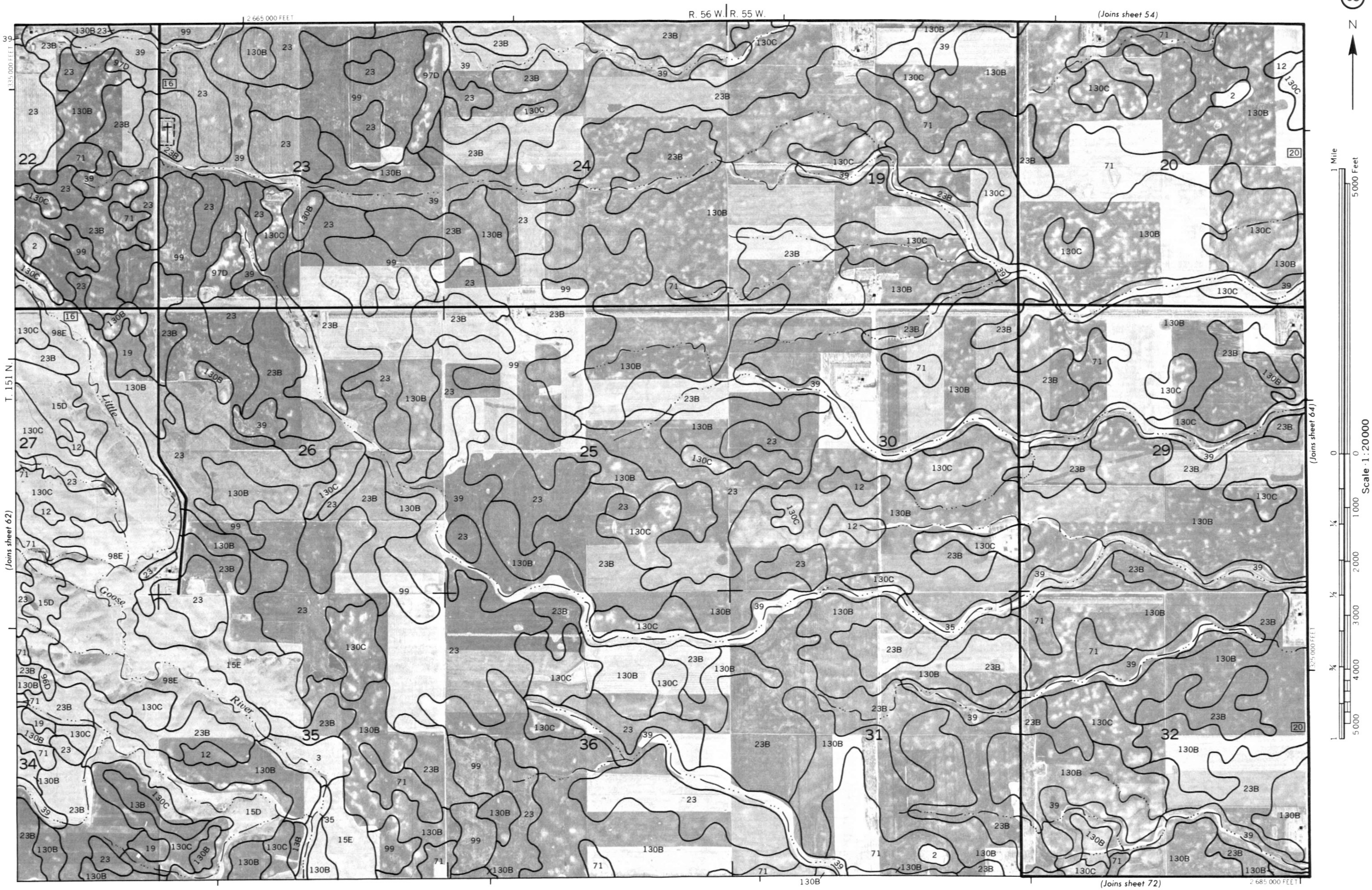

(Joins sheet 49)
R. 53 W.
R. 52 W.
2 775 000 FEET
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 67)
2 760 000 FEET
140 000 FEET
155 000 FEET
T. 151 N.
N
1 Mile
5000 Feet
Scale 1:20000
Emerado
Hazen
Brook
Salt
Water
Coulee
LAGOON
BURLINGTON
NORTHERN


(Joins sheet 50)
R. 52 W.
R. 51 W.
N
2 780 000 FEET
2 800 000 FEET
T. 151 N.
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 68)
Salt Water Coulee
Fresh Water Coulee
BURLINGTON NORTHERN
ENGLISH COULEE DIVERSION
1 Mile
5000 Feet
Scale 1:20000

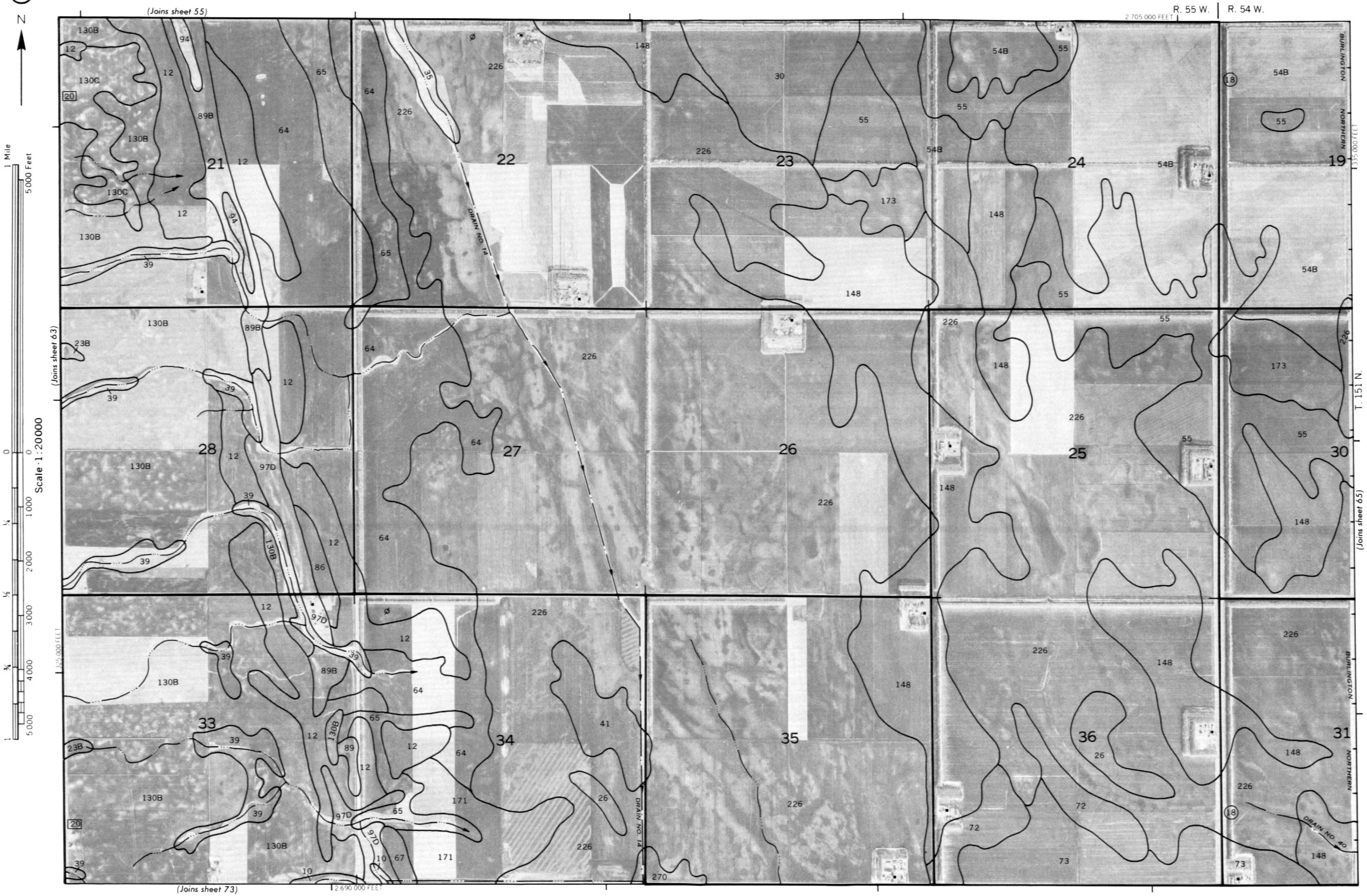

(Joins sheet 51)
R. 51 W.
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 69)
T. 151 N.
2 825 000 FEET
2 805 000 FEET
DRAIN NO. 18
DRAIN NO. 9
ENGLISH COULEE DIVERSION
English Coulee
BURLINGTON NORTHERN
N
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18
95
270
126
8
26
79B
11
35


61
N
R. 51 W.
R. 50 W.
(Joins sheet 52)
(Joins sheet 60)
(Joins inset, sheet 34)
(Joins sheet 70)
T. 151 N.
GRAND FORKS
(county seat)
POLK
CO.
MN.
RED
RIVER
DRAIN NO. 18
DRAIN NO. 9
English
Coulee
BURLINGTON
NORTHERN
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18
95
270
126
79B
226
8
43B
790
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000


(Joins sheet 53)
R. 56 W.
2 660 000 FEET
335 000 FEET
NELSON COUNTY
T. 151 N.
(Joins sheet 62)
(Joins sheet 71)
2 640 000 FEET
320 000 FEET
N
1 Mile
5 000 Feet
Scale 1:20000
water
intermittent


N
R. 56 W.
R. 55 W.
T. 151 N.
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 72)
2 665 000 FEET
2 685 000 FEET
Little
Goose
River
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 Mile
5000 Feet
Scale 1:20000

GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 64

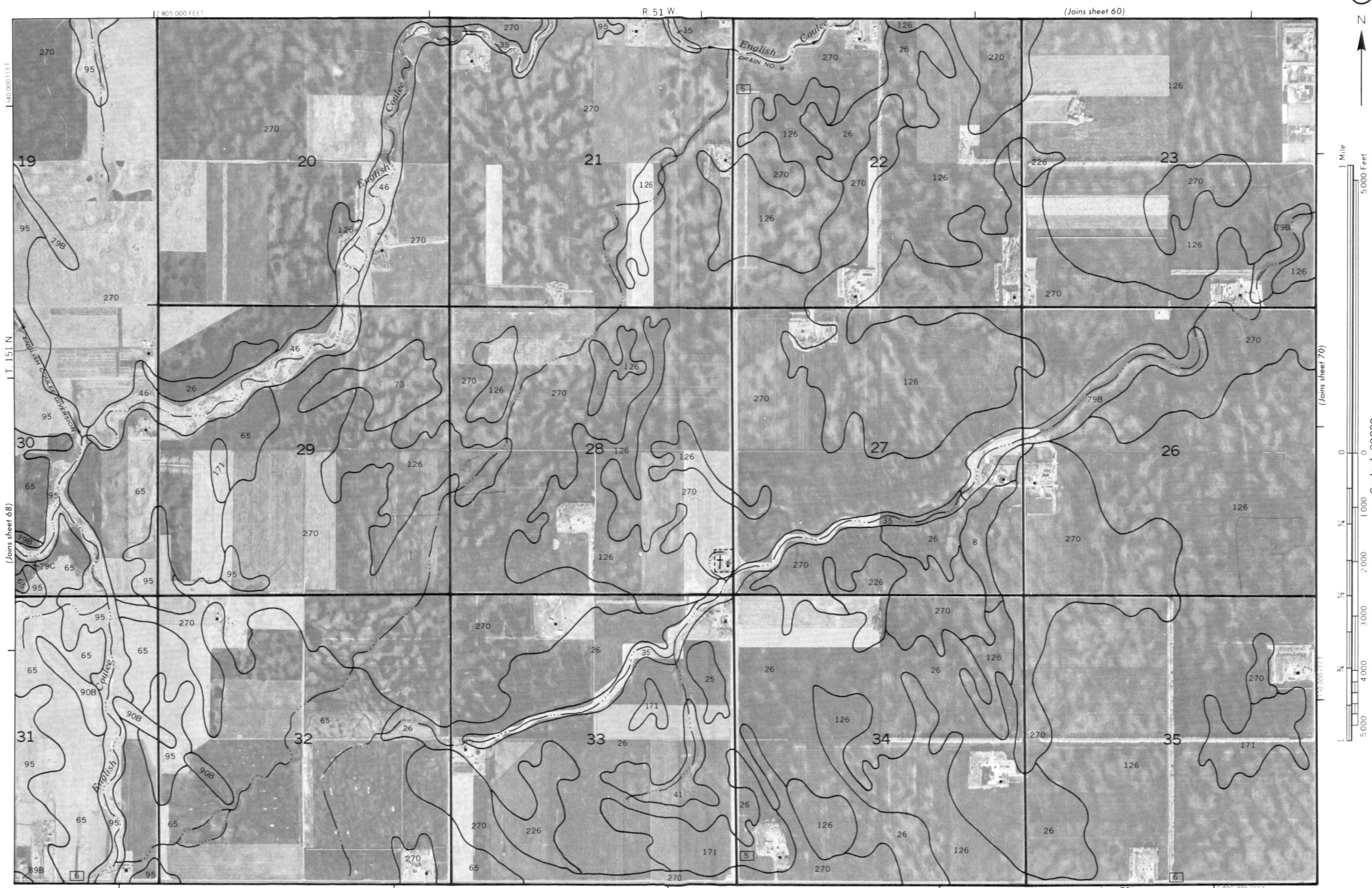


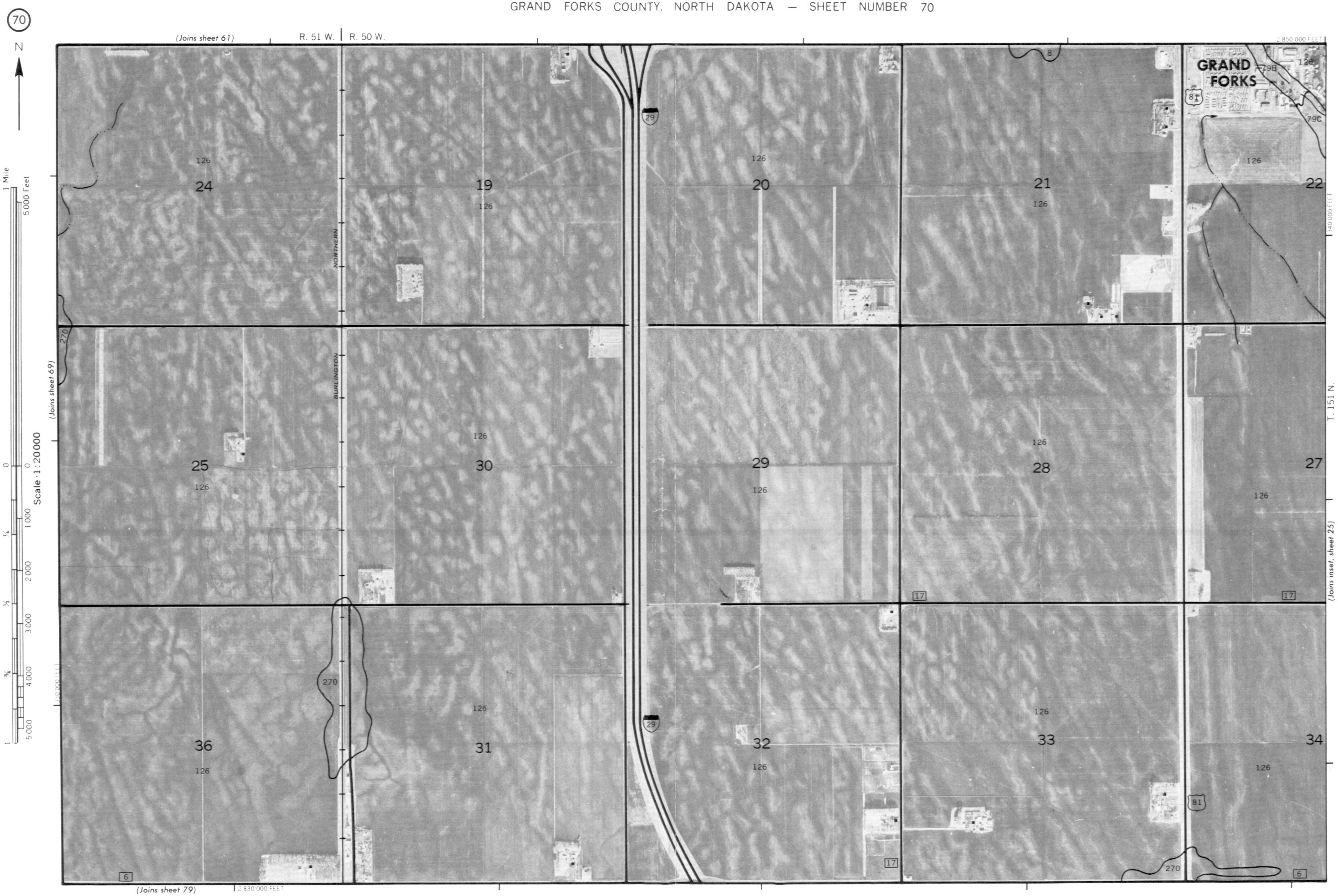

R. 54 W.
(Joins sheet 56)
(Joins sheet 64)
(Joins sheet 66)
(Joins sheet 74)
T. 151 N.
2 710 000 FEET
2 730 000 FEET
DRAIN NO. 42
DRAIN NO. 40
Hazen Brook
N
Scale 1:20000
1 Mile
5000 Feet
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 66

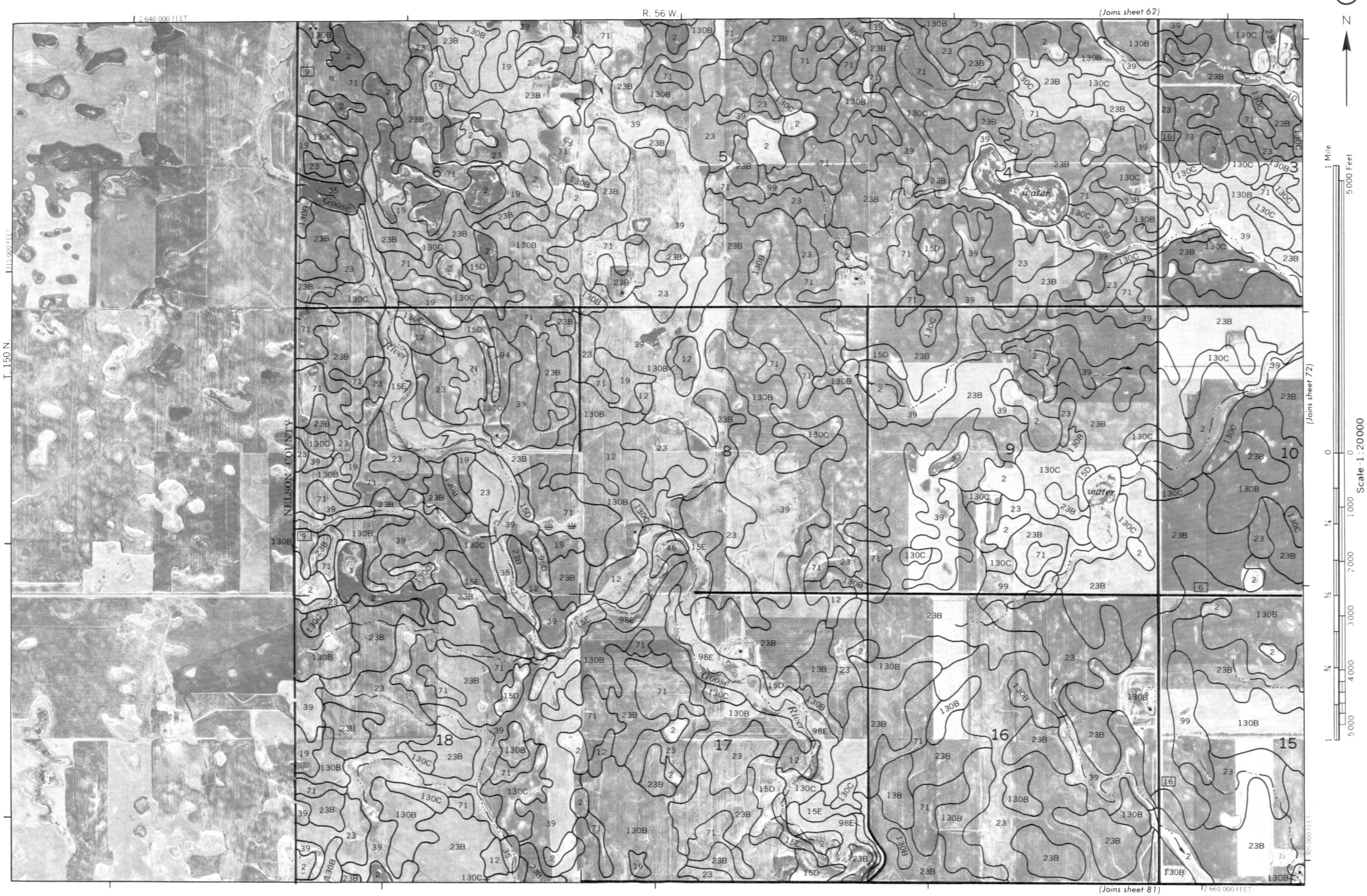

(Joins sheet 58)
(Joins sheet 68)
(Joins sheet 76)
(Joins sheet 66)
R. 53 W.
R. 52 W.
T. 151 N.
2 760 000 FEET
2 775 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
Salt Coulee
water
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32

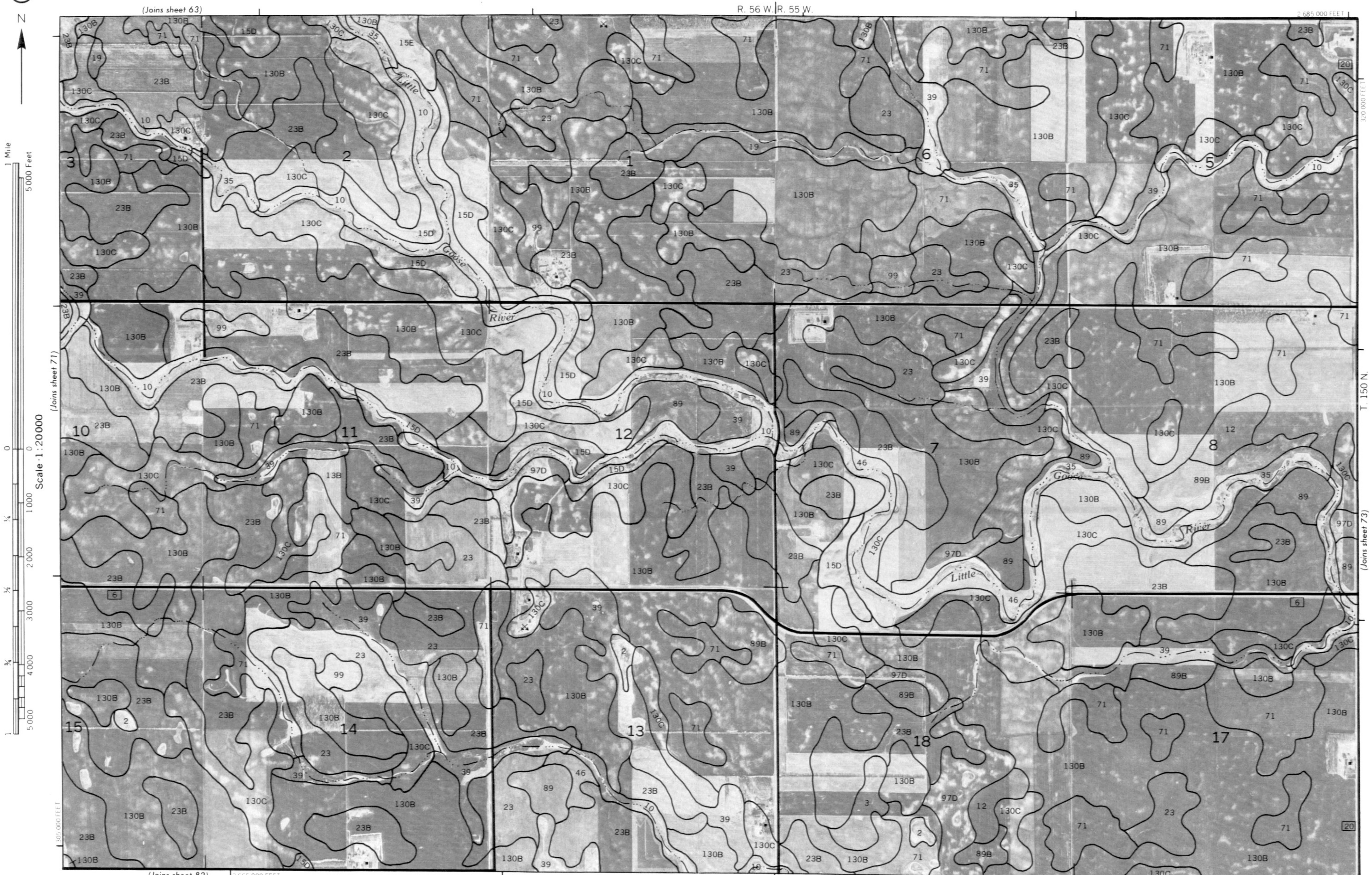

68
N
(Joins sheet 59)
(Joins sheet 67)
(Joins sheet 69)
(Joins sheet 77)
R. 52 W.
R. 51 W.
T. 151 N.
2 800 000 FEET
2 780 000 FEET
140 000 FEET
125 000 FEET
Scale 1:20 000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
Salt Coulee
Fresh Water Coulee
Water Coulee
ENGLISH COULEE DIVERSION
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
6

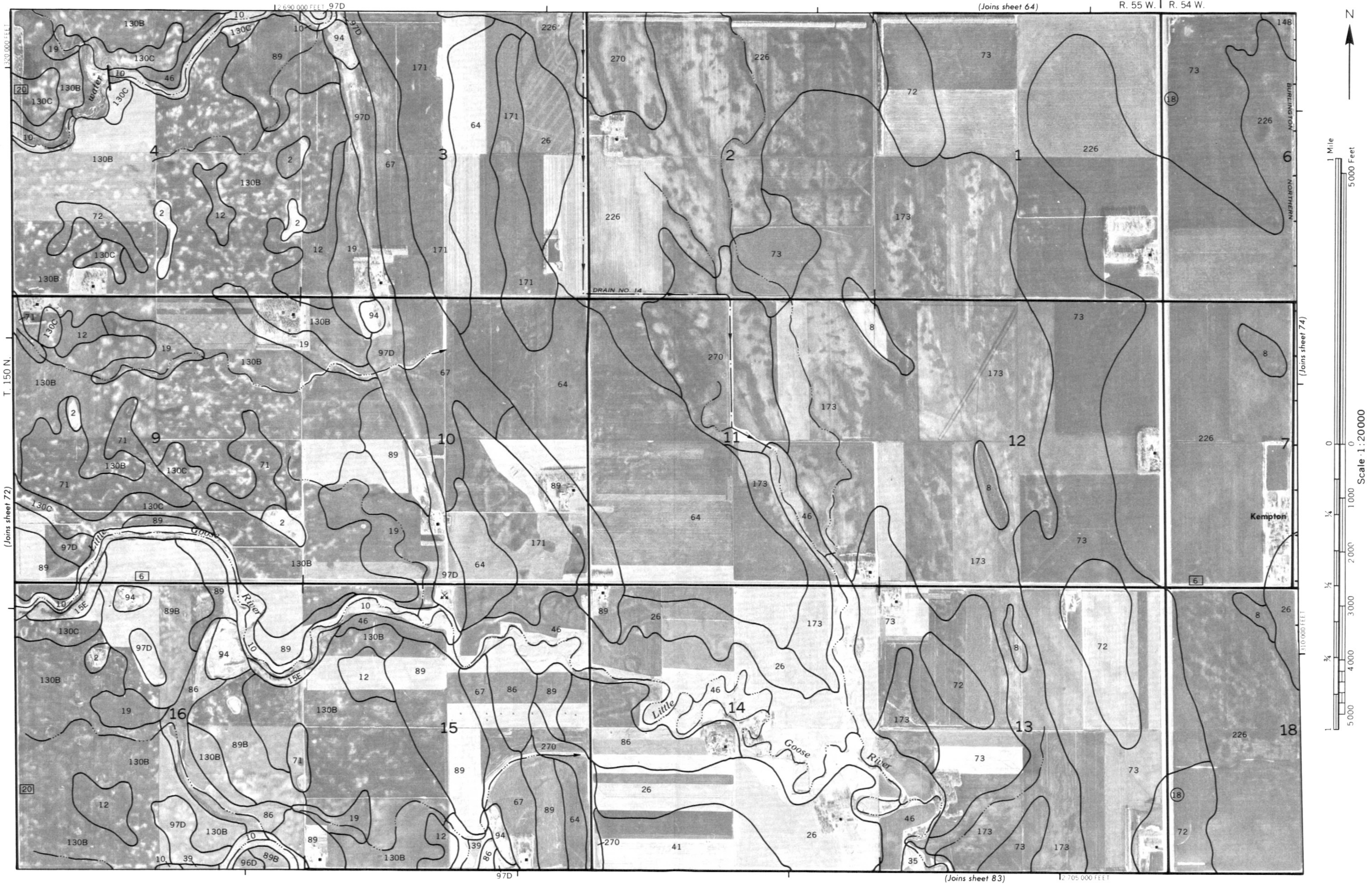

69
N
R. 51 W.
(Joins sheet 60)
(Joins sheet 68)
(Joins sheet 70)
(Joins sheet 78)
T. 151 N.
2 805 000 FEET
2 825 000 FEET
340 000 FEET
English Coulee
English Drain No. 9
English Coulee Diversion
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 Mile
5000 Feet
Scale 1:20000


70
N
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Scale 1:20000
(Joins sheet 61)
R. 51 W.
R. 50 W.
2 850 000 FEET
GRAND FORKS
79B
79C
81
29
NORTHERN
BURLINGTON
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
126
270
17
6
T. 151 N.
(Joins sheet 69)
(Joins inset, sheet 25)
(Joins sheet 79)
2 830 000 FEET

GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 71

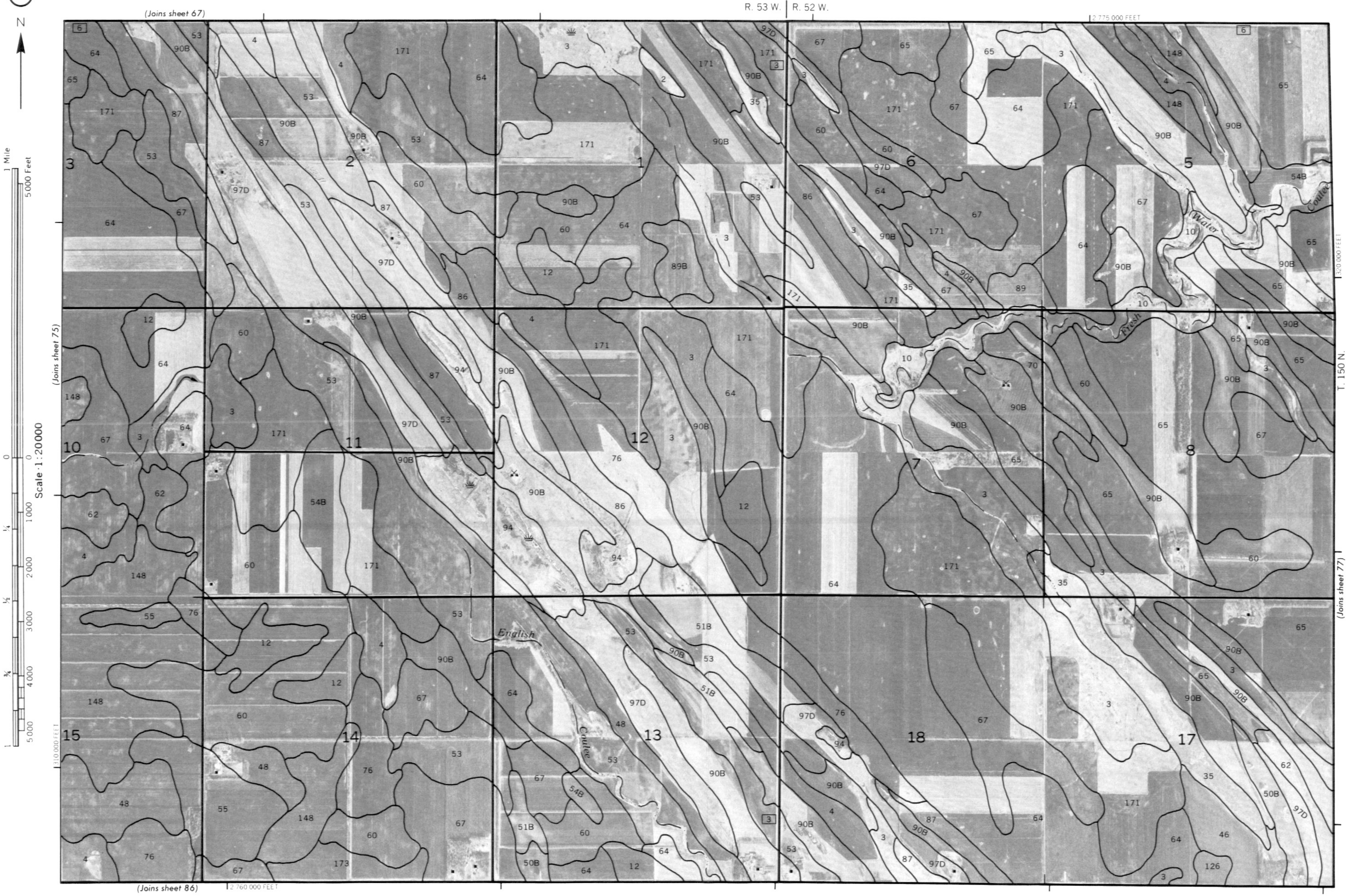



N
(Joins sheet 63)
R. 56 W. R. 55 W.
2 685 000 FEET
320 000 FEET
T. 150 N.
(Joins sheet 73)
(Joins sheet 82)
2 665 000 FEET
305 000 FEET
(Joins sheet 71)
Scale 1:20000
1 Mile
5000 Feet
Little Goose River
Little Goose River


(Joins sheet 64)
R. 55 W.
R. 54 W.
(Joins sheet 72)
(Joins sheet 74)
(Joins sheet 83)
T. 150 N.
2 690 000 FEET
2 705 000 FEET
DRAIN NO. 14
BURLINGTON NORTHERN
Kempton
Little Goose River
water
N
1 Mile
5000 Feet
Scale 1:20000

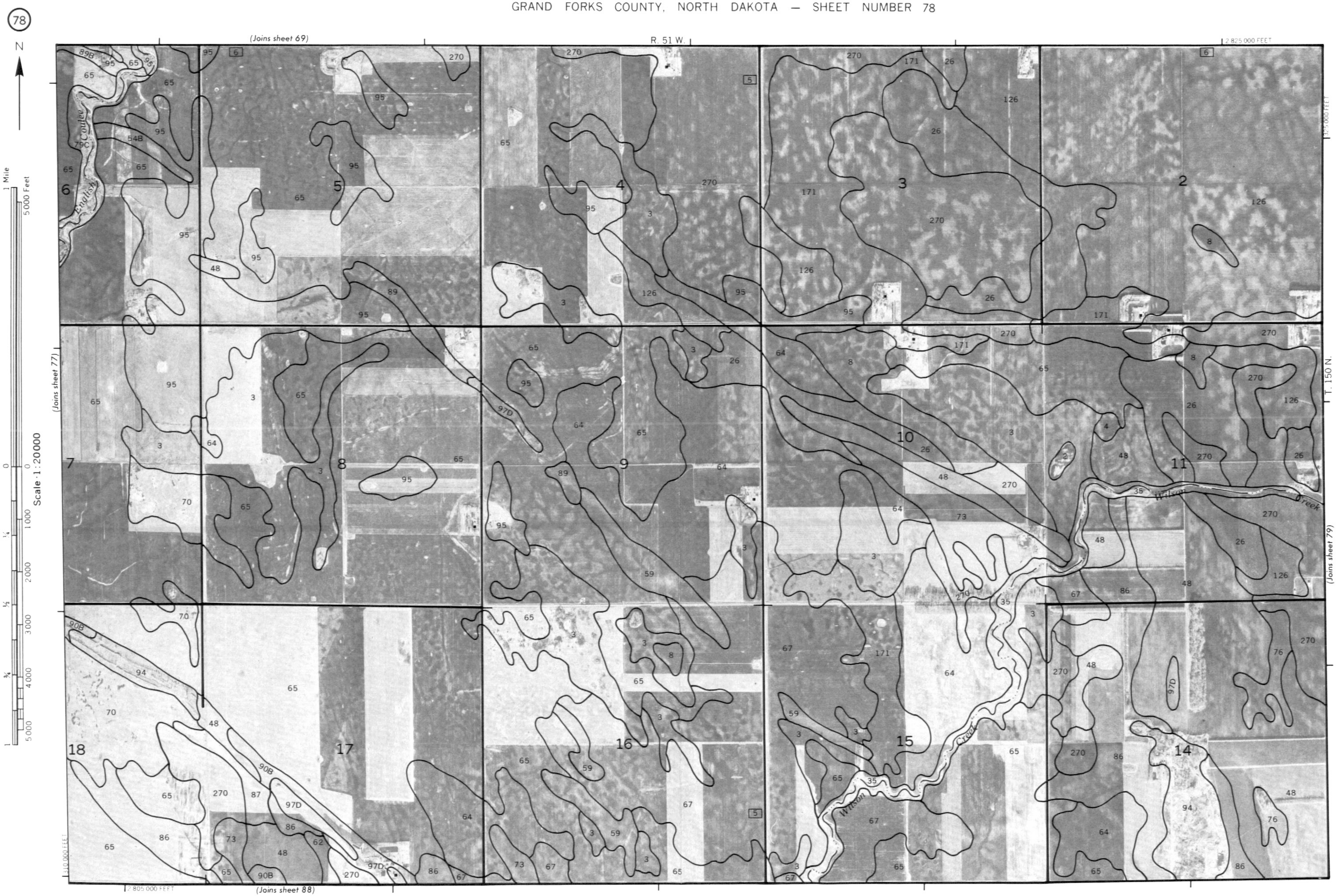

(Joins sheet 65)
R. 54 W.
2 730 000 FEET
(Joins sheet 73)
(Joins sheet 75)
(Joins sheet 84)
T. 150 N.
2 710 000 FEET
N
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Kempton
BURLINGTON NORTHERN
DRAIN NO. 40
Hazen Brook
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14

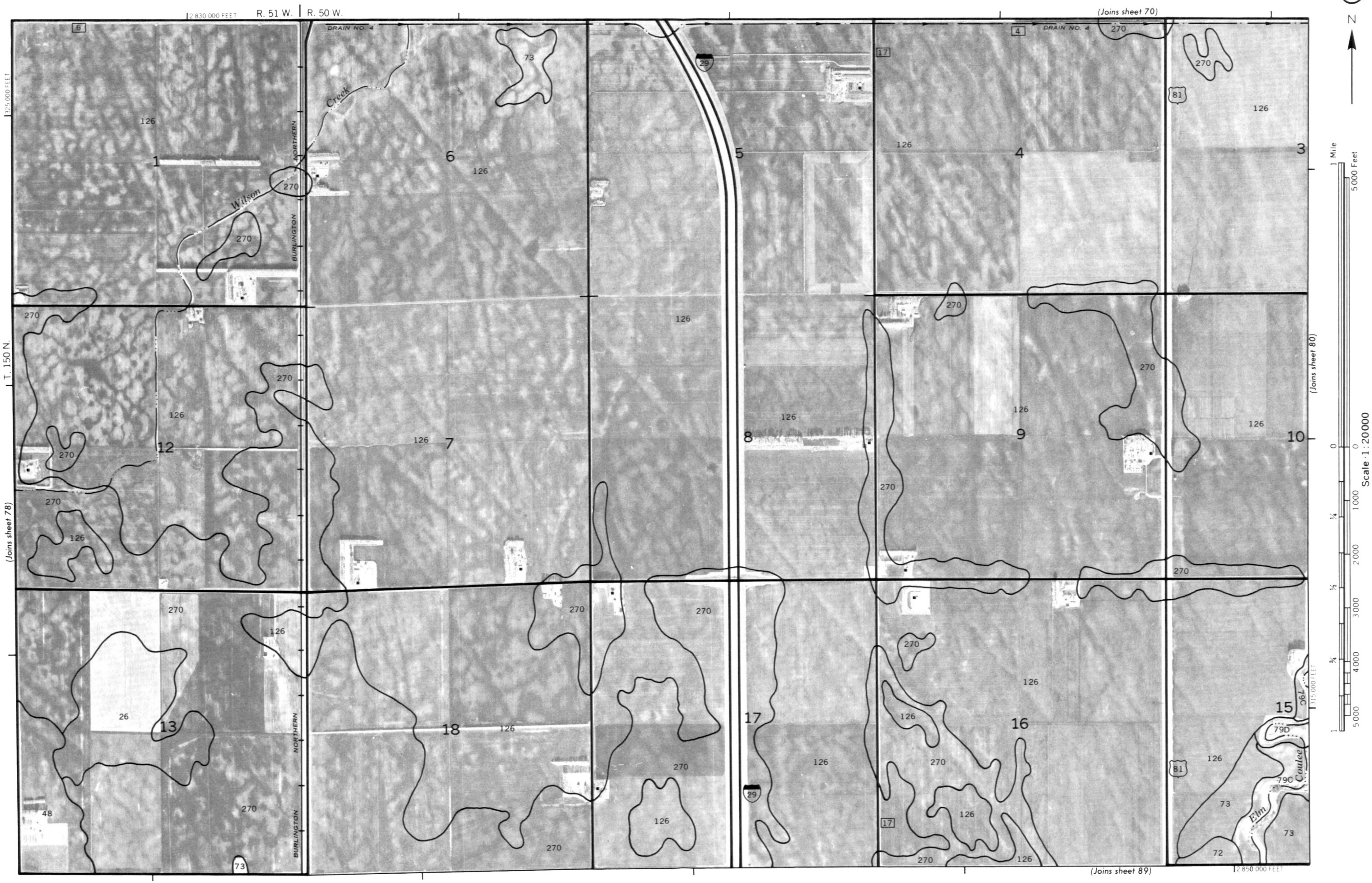

(Joins sheet 66)
(Joins sheet 76)
(Joins sheet 85)
(Joins sheet 74)
R. 54 W.
R. 53 W.
T. 150 N.
2 735 000 FEET
2 755 000 FEET
320 000 FEET
310 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
1
6
5
4
3
12
7
8
9
10
13
18
17
16
15


N
(Joins sheet 67)
R. 53 W.
R. 52 W.
2 775 000 FEET
(Joins sheet 75)
T. 150 N.
(Joins sheet 77)
(Joins sheet 86)
2 760 000 FEET
1 Mile
5000 Feet
Scale 1:20000
Fresh Water Coulee
English Coulee

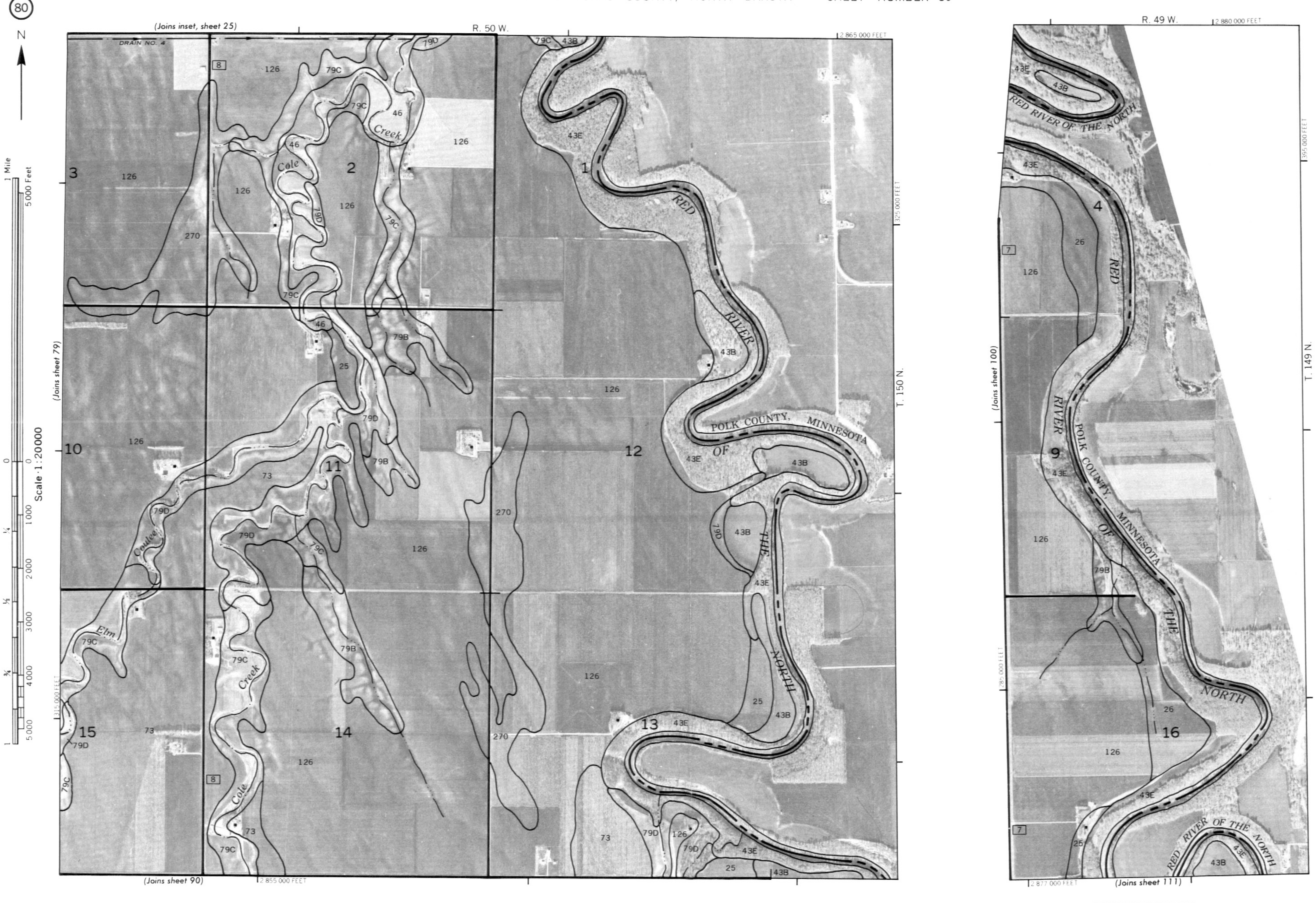

(Joins sheet 68)
(Joins sheet 78)
(Joins sheet 87)
(Joins sheet 76)
R. 52 W.
R. 51 W.
T. 150 N.
2 780 000 FEET
2 800 000 FEET
320 000 FEET
310 000 FEET
N
Fresh Water Coulee
English Coulee
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18
6
13
54B
64
65
70
90B
95
89B
126
148
8
62
50B
35
79C

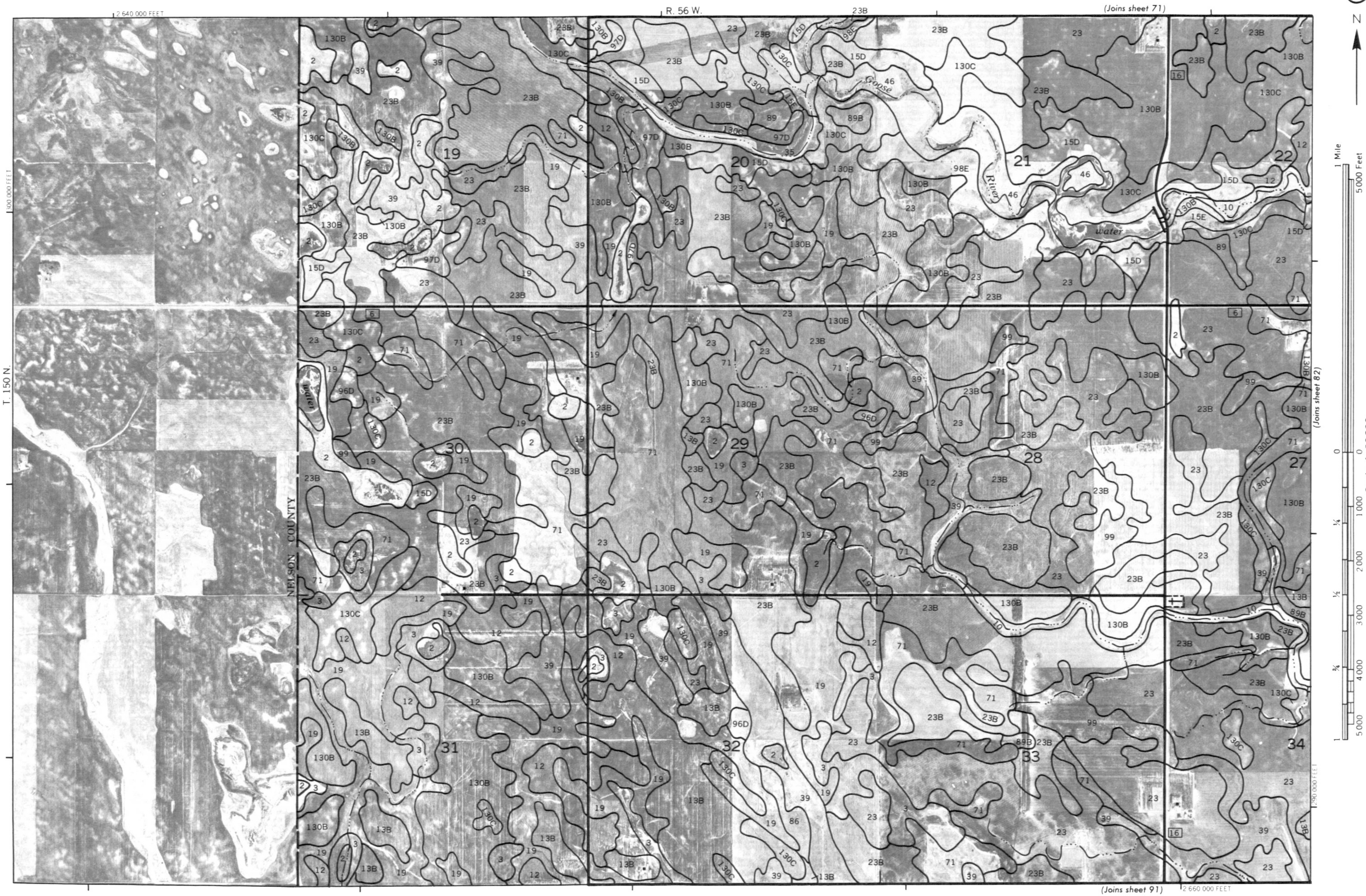
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 78

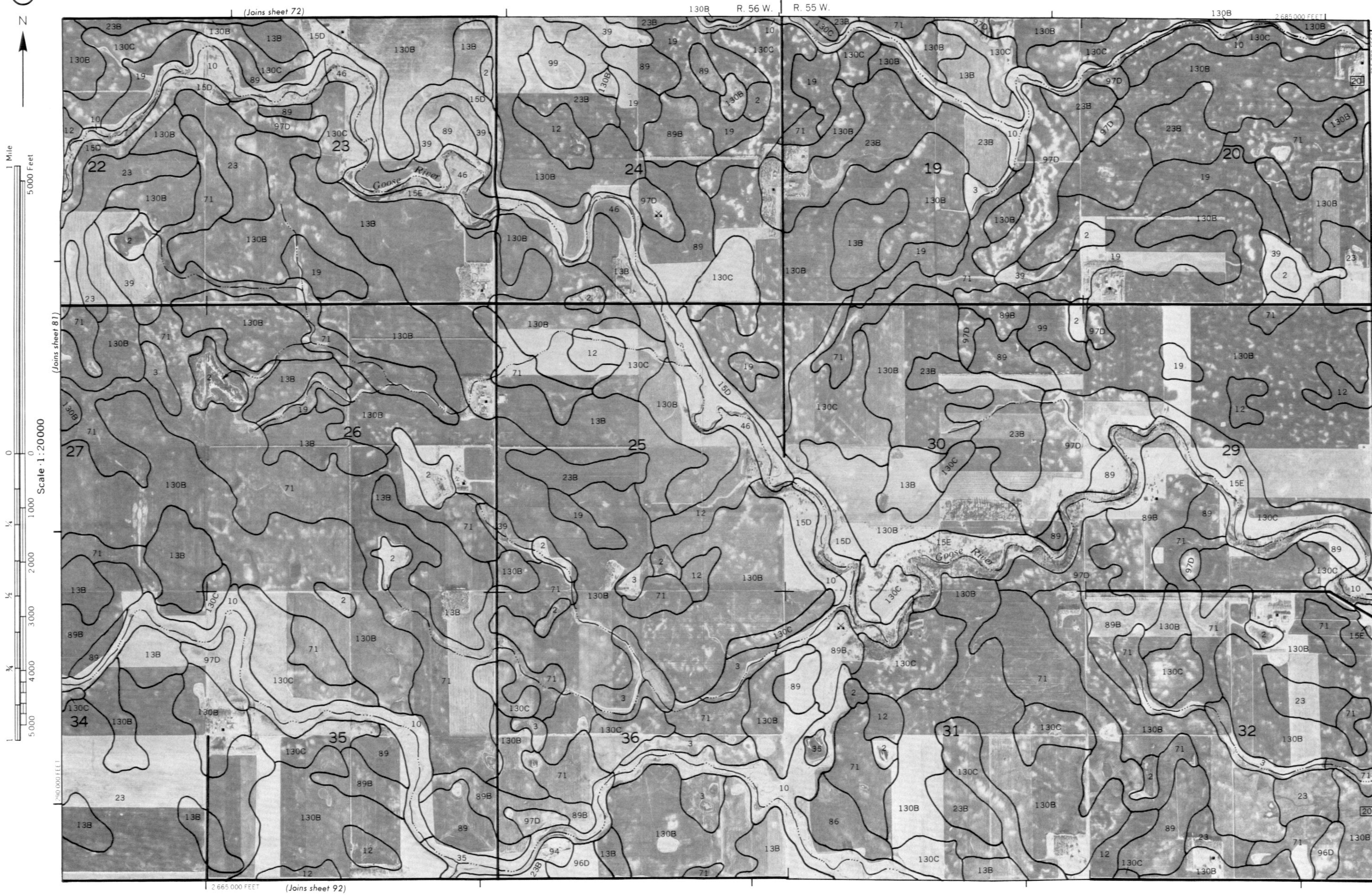




2 830 000 FEET
R. 51 W.
R. 50 W.
(Joins sheet 70)
N
DRAIN NO. 4
T. 150 N.
(Joins sheet 78)
(Joins sheet 80)
(Joins sheet 89)
2 850 000 FEET
315 000 FEET
325 000 FEET
Wilson
Creek
BURLINGTON
NORTHERN
Elm
Coulee
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18
126
270
73
26
48
72
79C
79D
29
81
17
6
4
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1000
2000
3000
4000
5000


80
N
(Joins inset, sheet 25)
DRAIN NO. 4
R. 50 W.
2 865 000 FEET
R. 49 W.
2 880 000 FEET
325 000 FEET
T. 150 N.
T. 149 N.
(Joins sheet 79)
(Joins sheet 100)
(Joins sheet 90)
2 855 000 FEET
2 877 000 FEET
(Joins sheet 111)
3000 AND 5000 FOOT GRID TICKS
1 Mile
5 000 Feet
Scale 1:20 000
Cole Creek
Coulee
Elm
RED RIVER OF THE NORTH
POLK COUNTY, MINNESOTA
1
2
3
4
9
10
11
12
13
14
15
16
8
7
25
26
43B
43E
46
73
79B
79C
79D
126
270

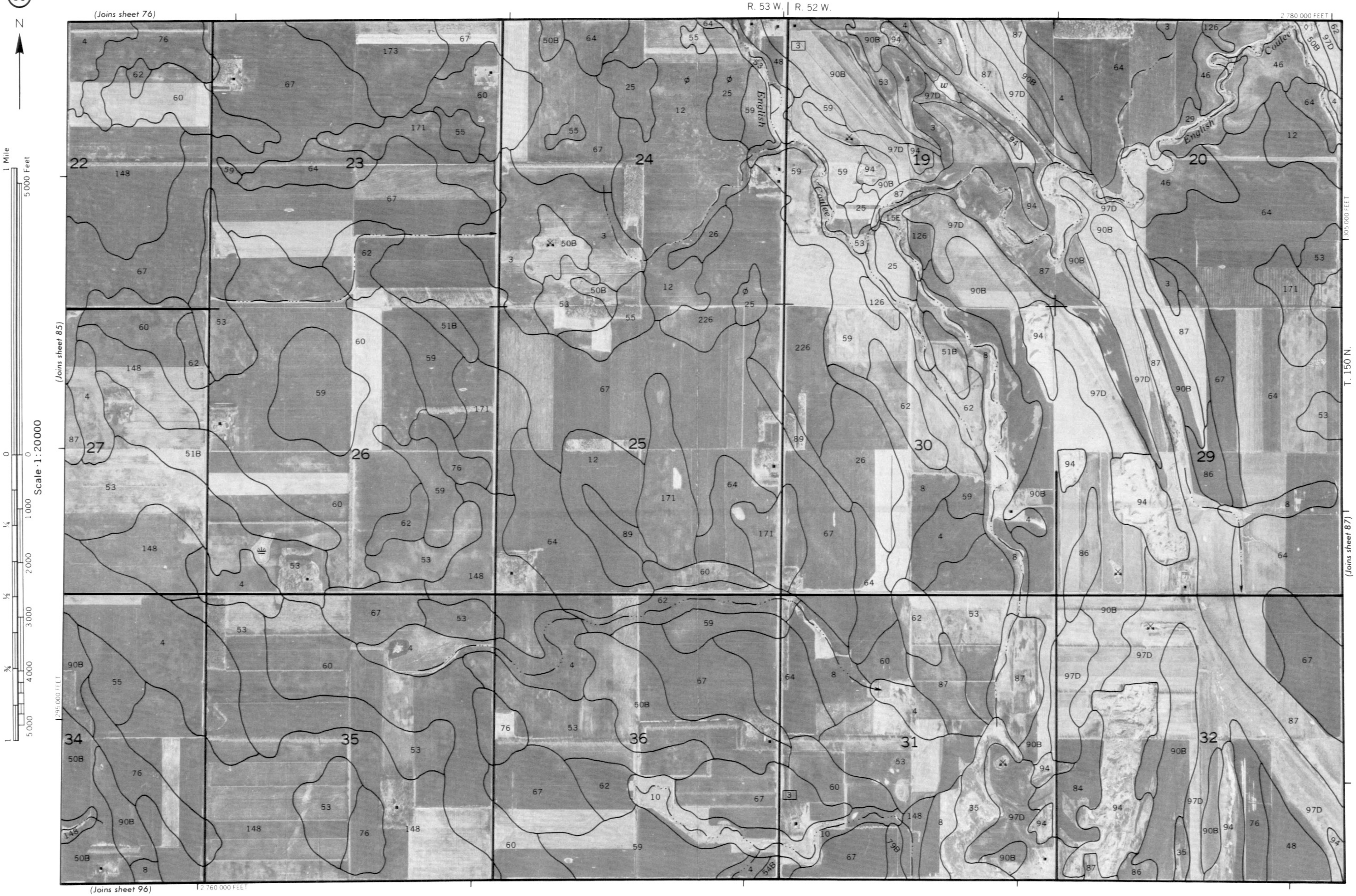

2 640 000 FEET
R. 56 W.
(Joins sheet 71)
N
T. 150 N.
300 000 FEET
NELSON COUNTY
(Joins sheet 82)
(Joins sheet 91)
2 660 000 FEET
290 000 FEET
Goose
River
Water
19
20
21
22
27
28
29
30
31
32
33
34
1 Mile
5000 Feet
Scale 1:20000


N
(Joins sheet 72)
R. 56 W.
R. 55 W.
(Joins sheet 81)
(Joins sheet 83)
(Joins sheet 92)
T. 150 N.
Scale 1:20000
1 Mile
5000 Feet
2 665 000 FEET
2 685 000 FEET
Goose River
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32

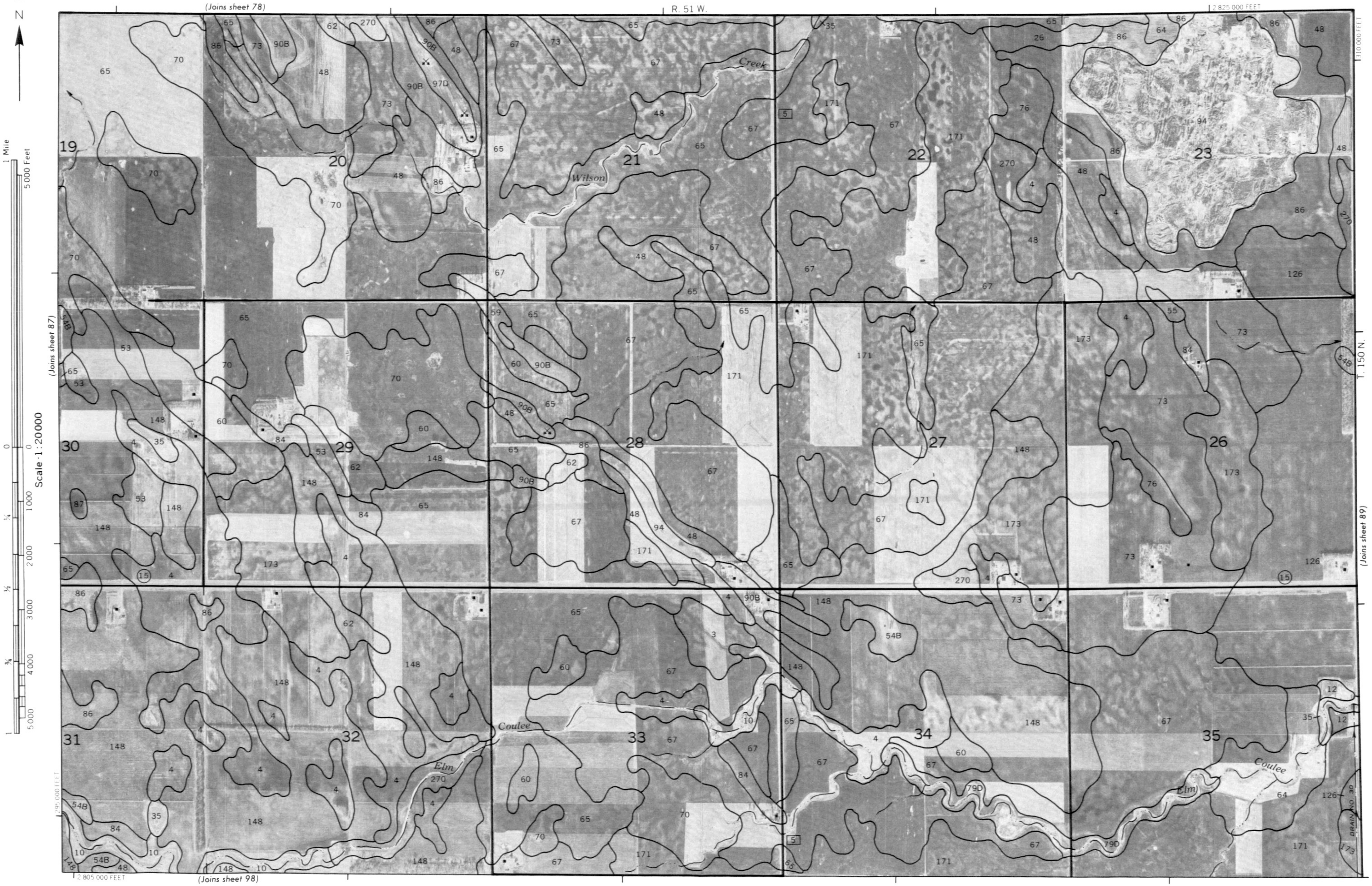

(Joins sheet 73)
R. 55 W.
R. 54 W.
T. 150 N.
(Joins sheet 82)
(Joins sheet 84)
(Joins sheet 93)
2 690 000 FEET
2 710 000 FEET
DRAIN NO. 40
Little Goose River
Goose River
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
N
1 Mile
5000 Feet
Scale 1:20000


(Joins sheet 74)
R. 54 W.
2 730 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 83)
T. 150 N.
(Joins sheet 85)
(Joins sheet 94)
2 715 000 FEET
BURLINGTON
NORTHERN
North Branch Goose River
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35


R. 54 W.
R. 53 W.
T. 150 N.
(Joins sheet 75)
(Joins sheet 84)
(Joins sheet 86)
(Joins sheet 95)
2 735 000 FEET
2 755 000 FEET
N
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
North Branch Goose River
1 Mile
5000 Feet
Scale 1:20000

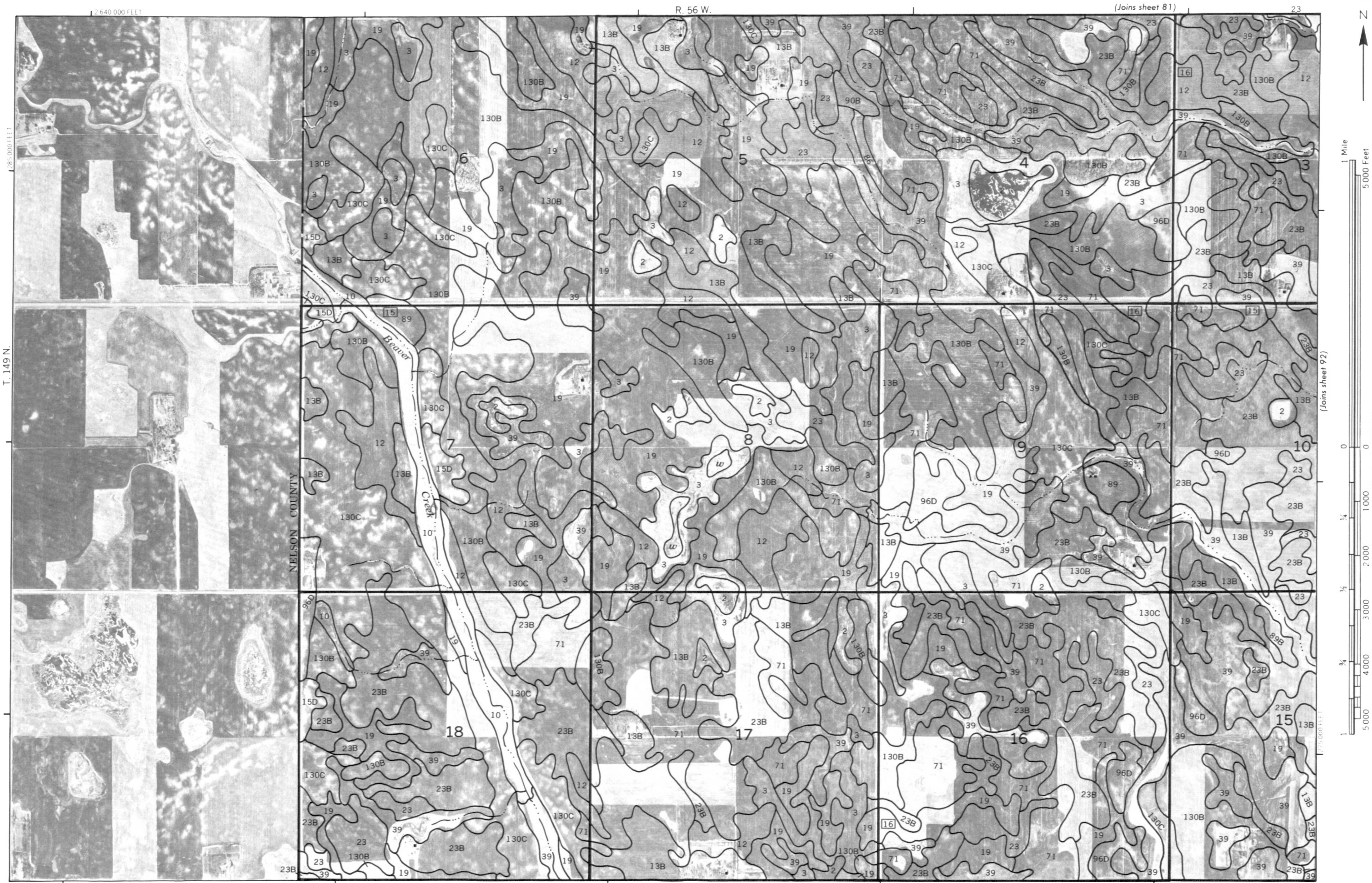

86
N
(Joins sheet 76)
(Joins sheet 85)
(Joins sheet 87)
(Joins sheet 96)
R. 53 W.
R. 52 W.
T. 150 N.
2 780 000 FEET
2 760 000 FEET
305 000 FEET
295 000 FEET
1 Mile
5000 Feet
Scale 1:20000
English
Coulee
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


(Joins sheet 77)
R. 52 W.
R. 51 W.
2 785 000 FEET
N
T. 150 N
(Joins sheet 86)
(Joins sheet 88)
(Joins sheet 97)
2 800 000 FEET
English Coulee
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
1 Mile
5000 Feet
Scale 1:20000

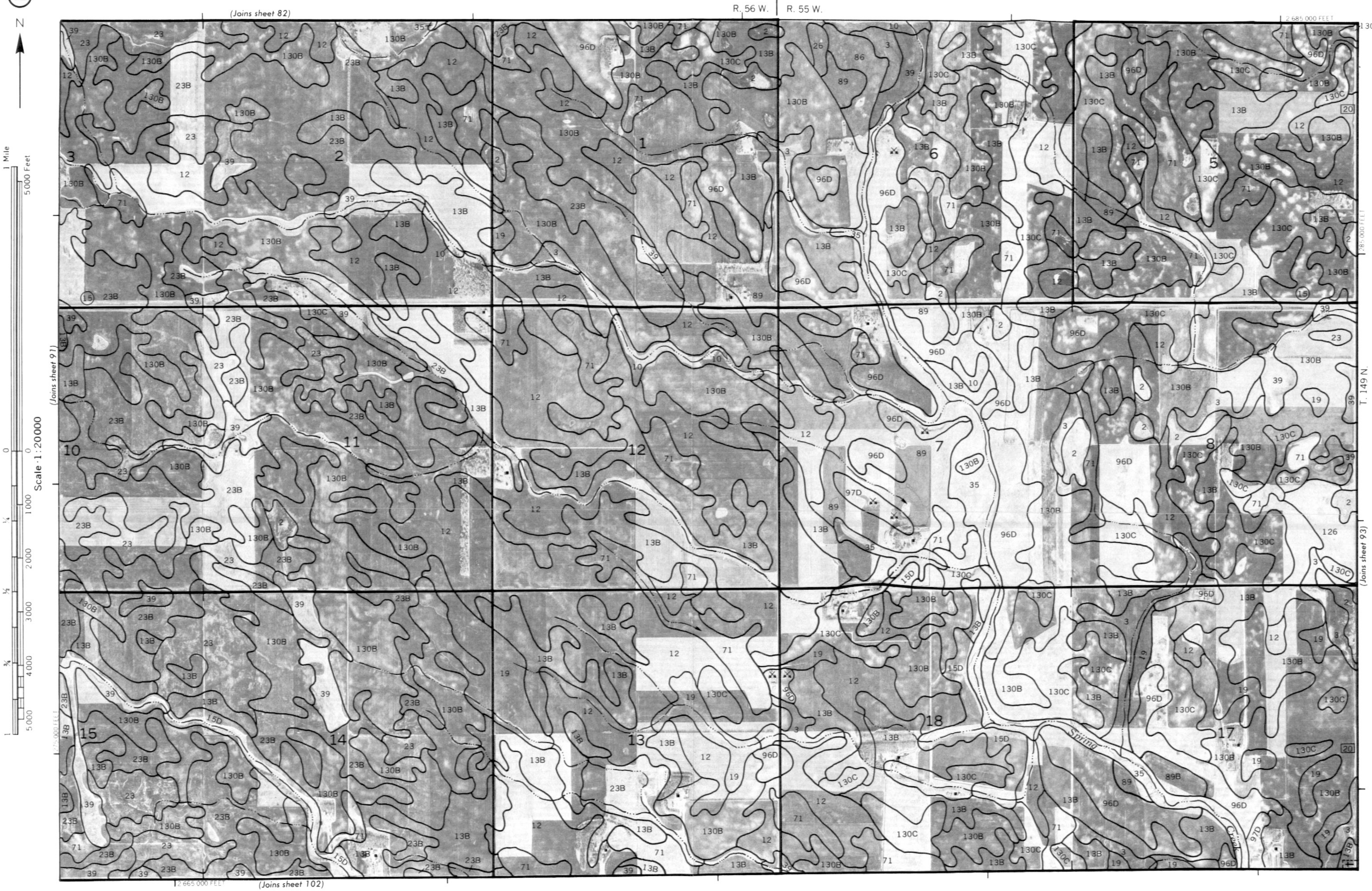

88
N
(Joins sheet 78)
R. 51 W.
2 825 000 FEET
(Joins sheet 87)
(Joins sheet 89)
(Joins sheet 98)
2 805 000 FEET
T. 150 N.
1 Mile
5000 Feet
Scale 1:20000
Wilson
Creek
Coulee
Elm
DRAIN NO. 30
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35

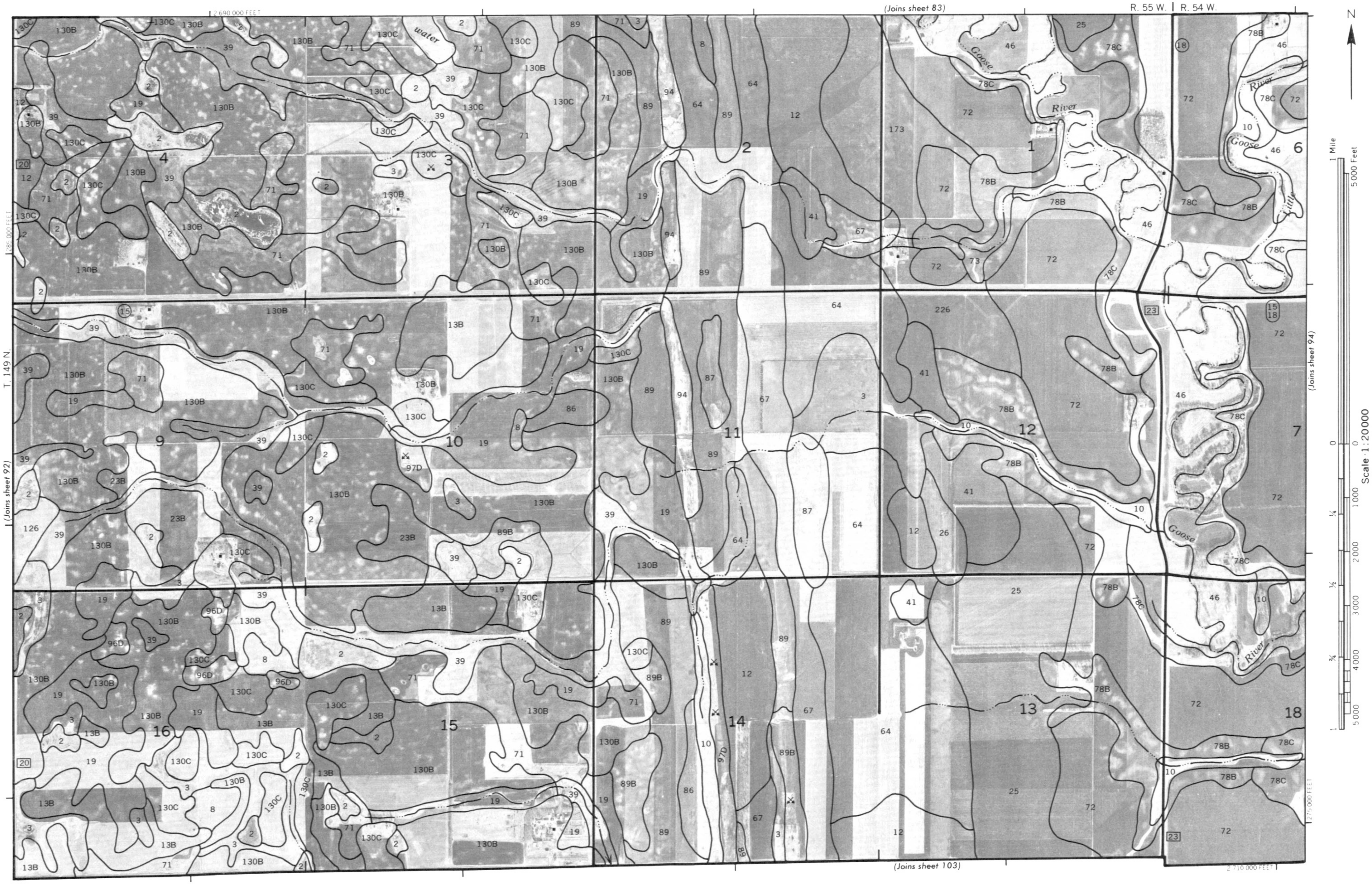

(Joins sheet 79)
(Joins sheet 88)
(Joins sheet 90)
(Joins sheet 99)
R. 51 W.
R. 50 W.
T. 150 N.
2 830 000 FEET
2 850 000 FEET
Thompson
NORTHERN
BURLINGTON
Elm
Coulee
LAGOON
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
N
1 Mile
5000 Feet
Scale 1:20000


N
(Joins sheet 80)
R. 50 W.
R. 49 W.
2 875 000 FEET
310 000 FEET
(Joins sheet 89)
T. 150 N.
300 000 FEET
2 855 000 FEET
(Joins sheet 100)
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
22
23
24
19
27
26
25
30
29
34
35
36
31
32
8
7
Cole Creek
RED RIVER OF THE NORTH
POLK COUNTY
MINNESOTA
73
79C
79B
79D
126
25
43B
43E
11
78B
78C
46
10

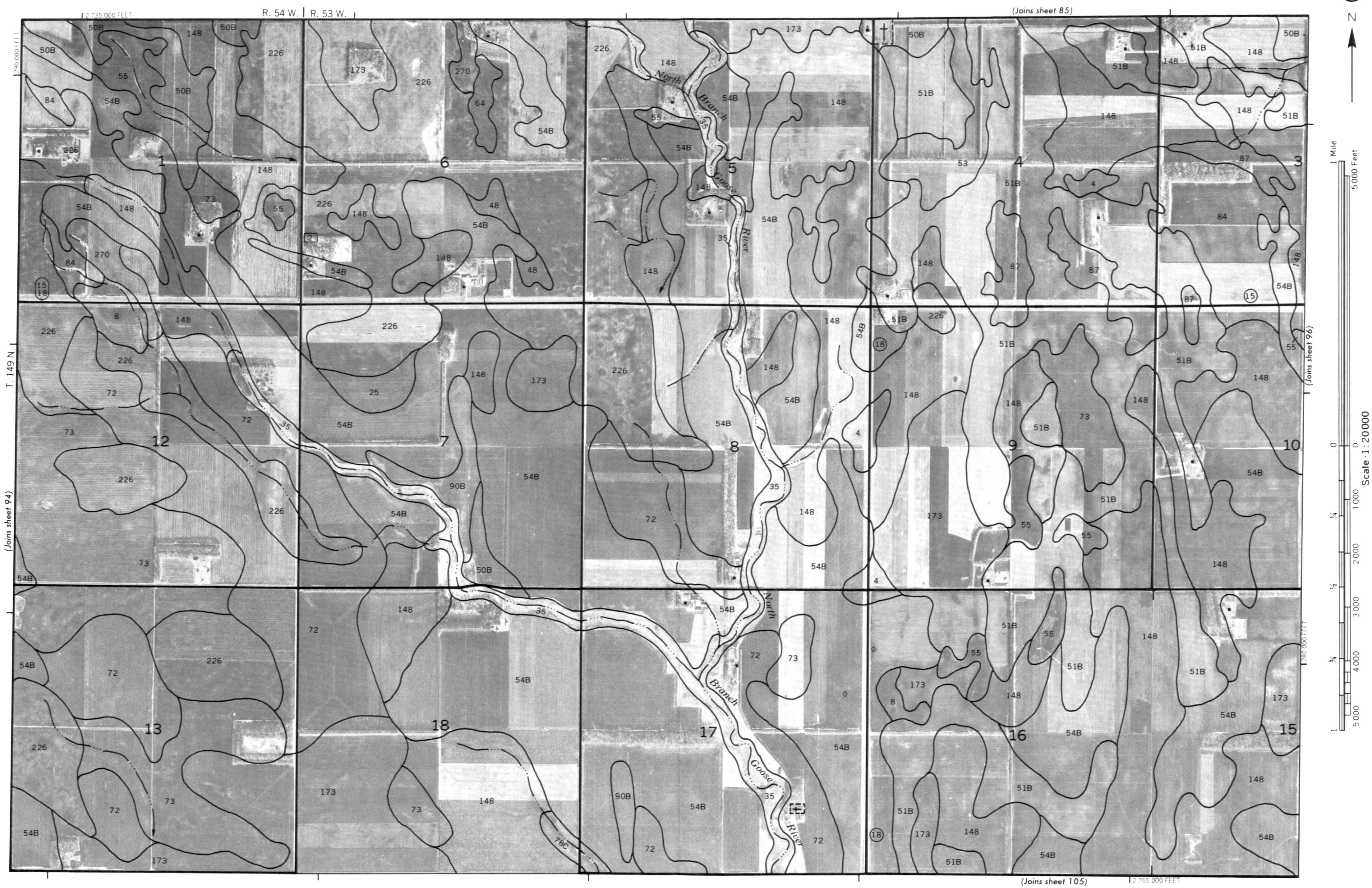

R. 56 W.
(Joins sheet 81)
(Joins sheet 92)
(Joins sheet 101)
T. 149 N.
NELSON COUNTY
Beaver Creek
2 640 000 FEET
2 660 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000

GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 92

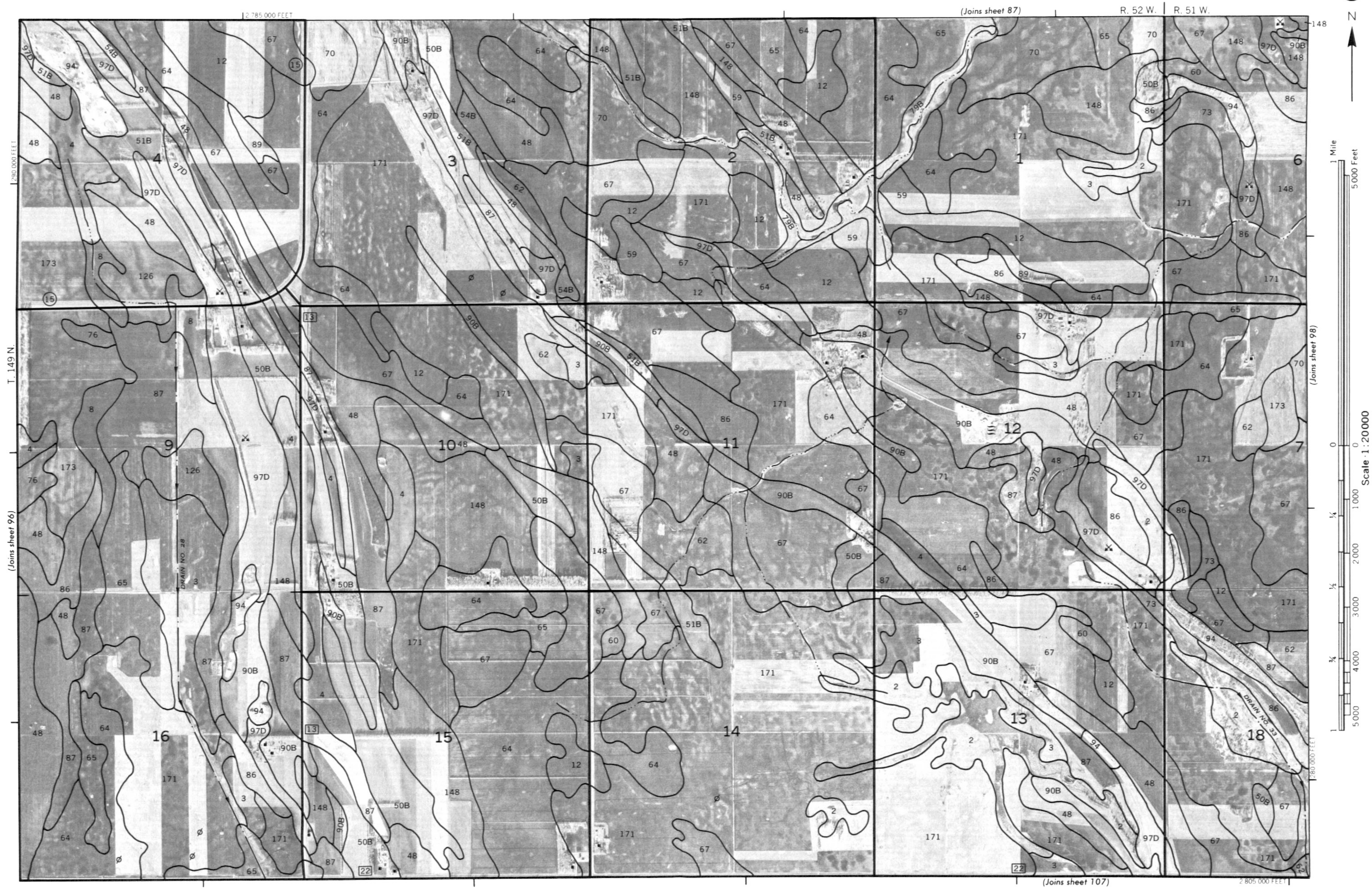


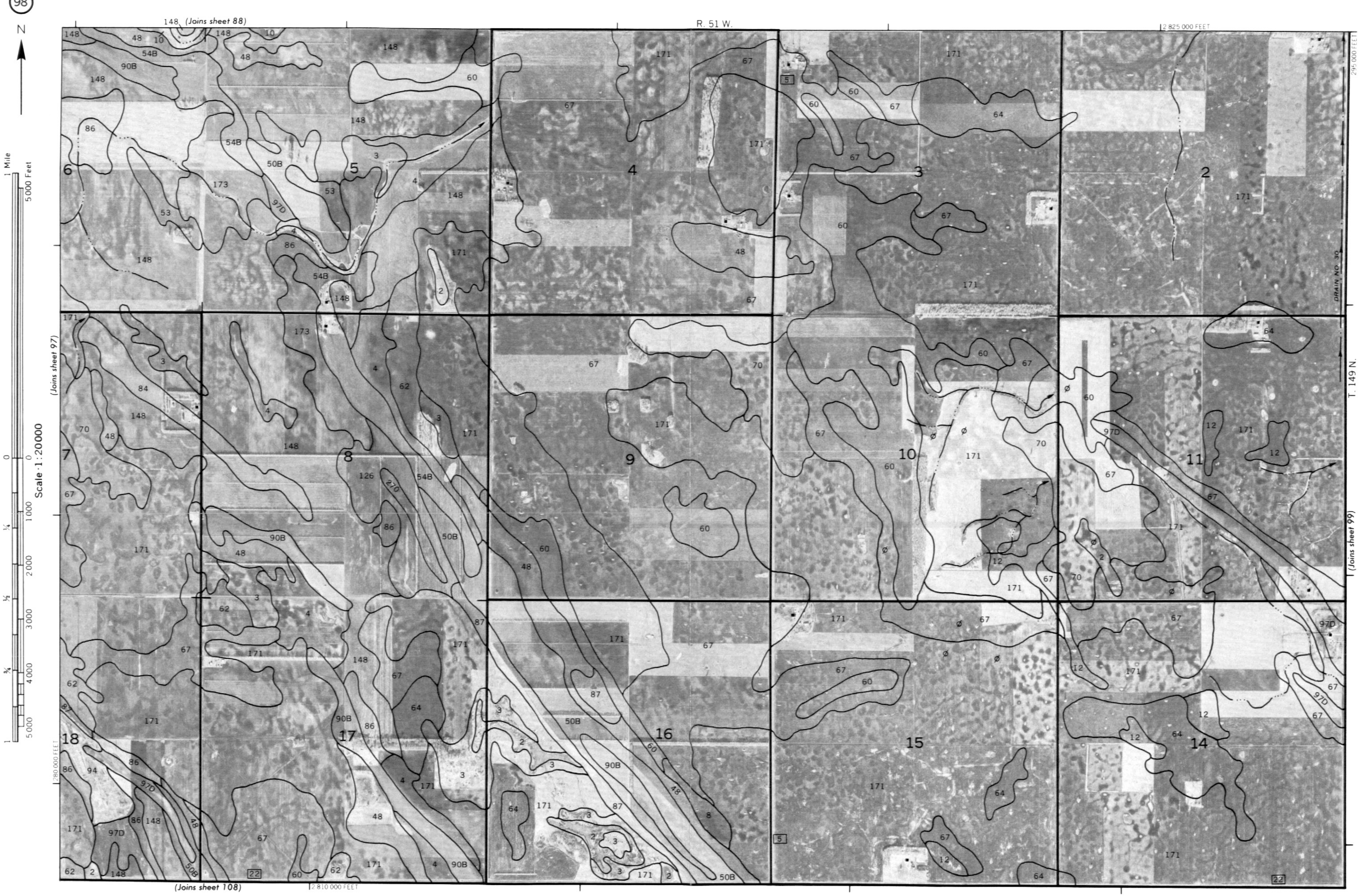

(Joins sheet 83)
(Joins sheet 92)
(Joins sheet 94)
(Joins sheet 103)
R. 55 W.
R. 54 W.
T. 149 N.
2 690 000 FEET
2 710 000 FEET
275 000 FEET
285 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
Goose River
Little Goose River
water
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18

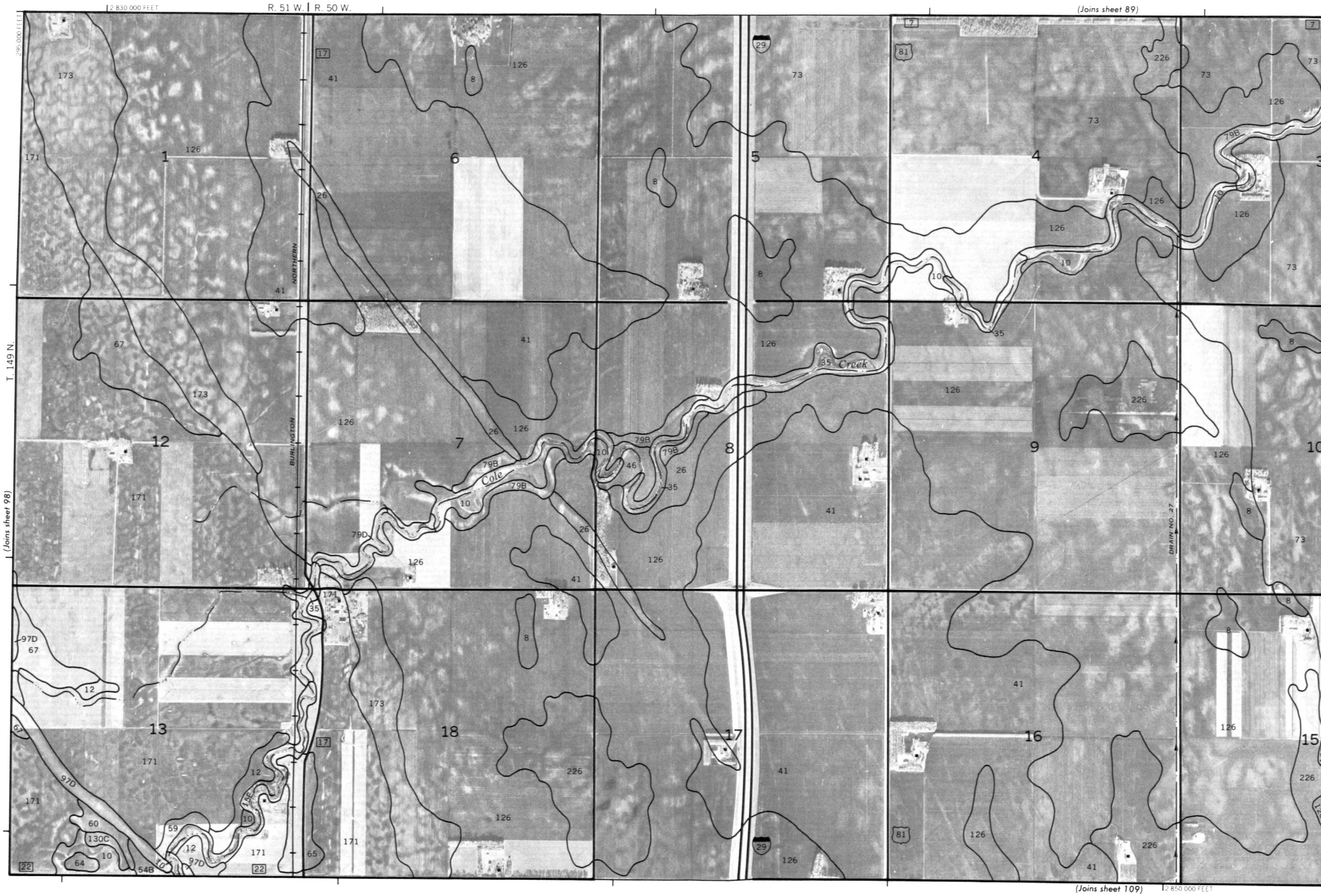
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 94


95
N
R. 54 W.
R. 53 W.
2 735 000 FEET
290 000 FEET
(Joins sheet 85)
T. 149 N.
(Joins sheet 94)
(Joins sheet 96)
(Joins sheet 105)
2 755 000 FEET
280 000 FEET
North Branch Goose River
1 Mile
5000 Feet
Scale 1:20000
1
6
5
4
3
12
7
8
9
10
13
18
17
16
15


N
(Joins sheet 86)
R. 53 W.
R. 52 W.
2 780 000 FEET
290 000 FEET
T. 149 N.
(Joins sheet 95)
(Joins sheet 97)
(Joins sheet 106)
2 760 000 FEET
280 000 FEET
1 Mile
5000 Feet
Scale 1:20000


(Joins sheet 87)
R. 52 W.
R. 51 W.
T. 149 N.
(Joins sheet 96)
(Joins sheet 98)
(Joins sheet 107)
2 785 000 FEET
2 805 000 FEET
290 000 FEET
280 000 FEET
DRAIN NO. 28
DRAIN NO. 33
N
1 Mile
5 000 Feet
Scale 1:20000


N
148 (Joins sheet 88)
R. 51 W.
2 825 000 FEET
295 000 FEET
DRAIN NO. 30
T. 149 N.
(Joins sheet 97)
(Joins sheet 99)
(Joins sheet 108)
2 810 000 FEET
280 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14

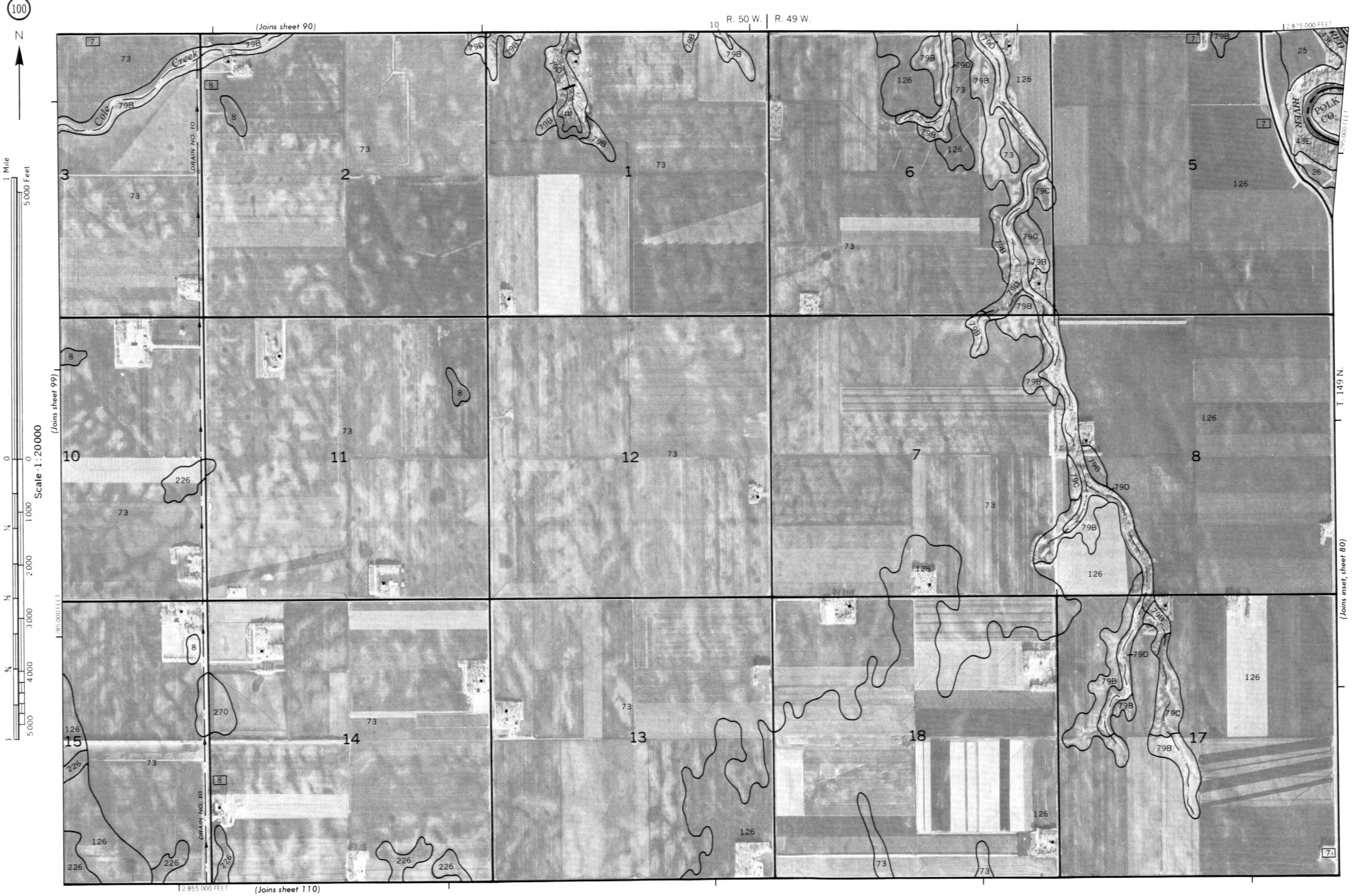


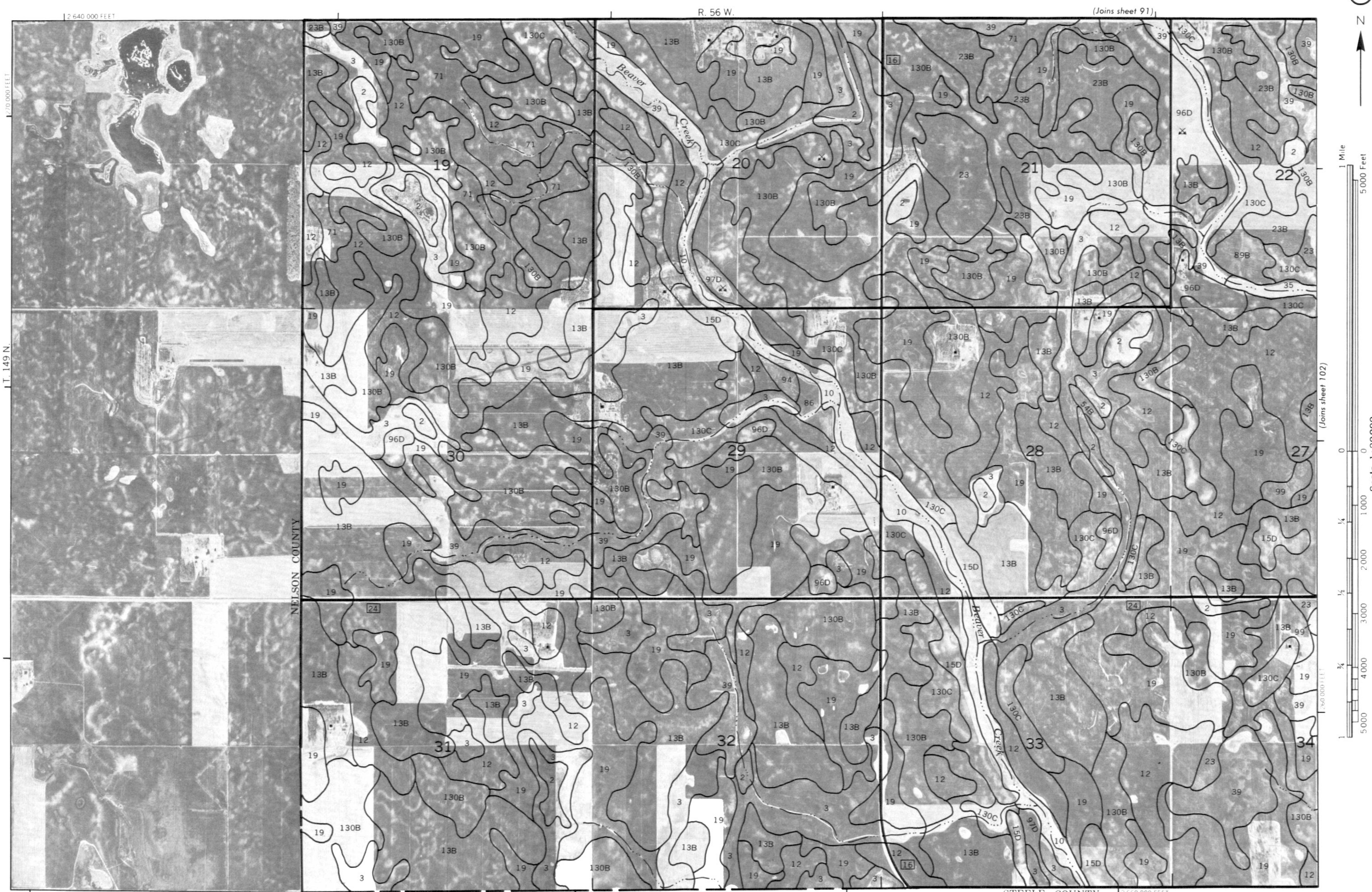
N

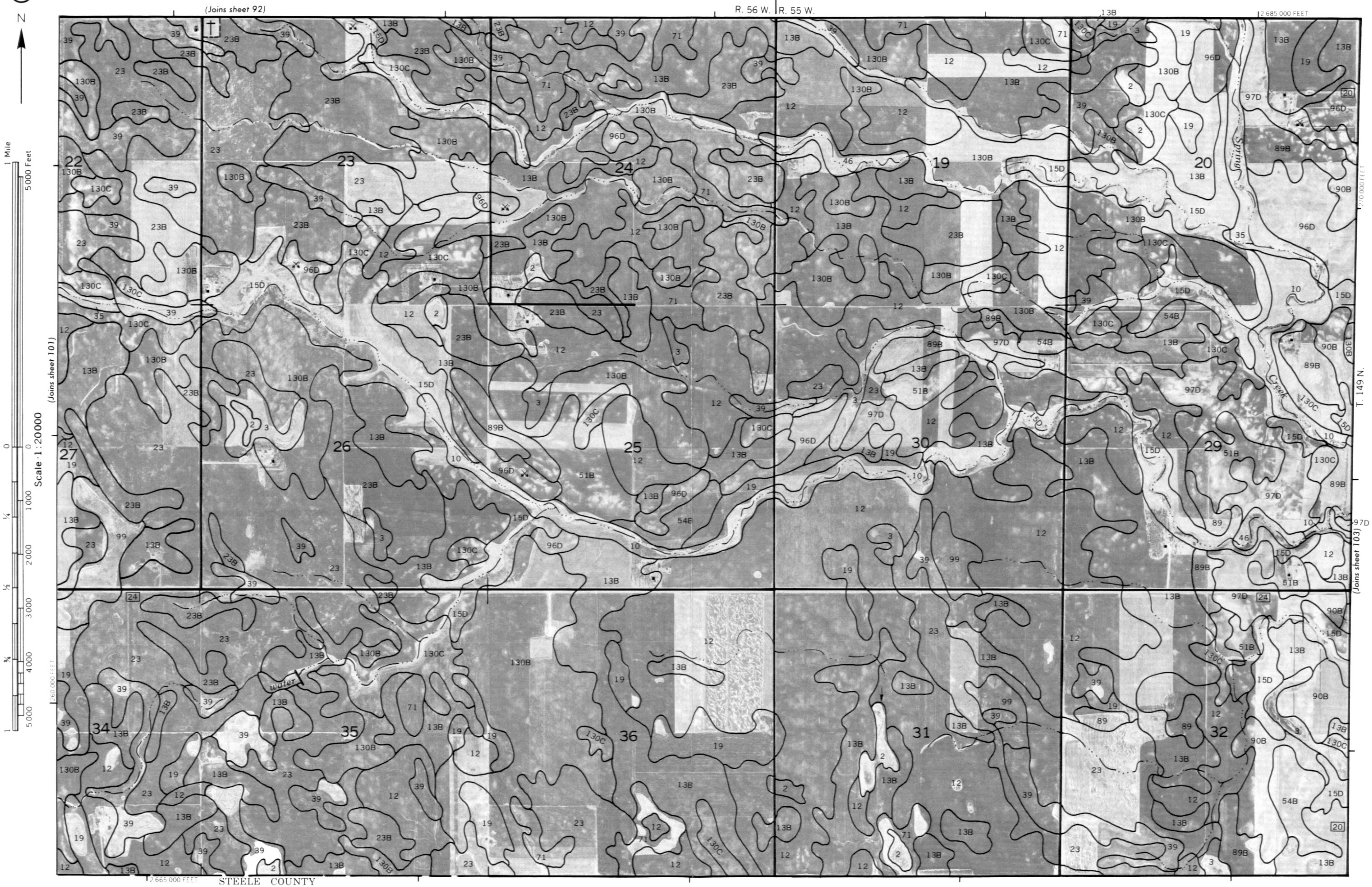
Scale 1:20 000

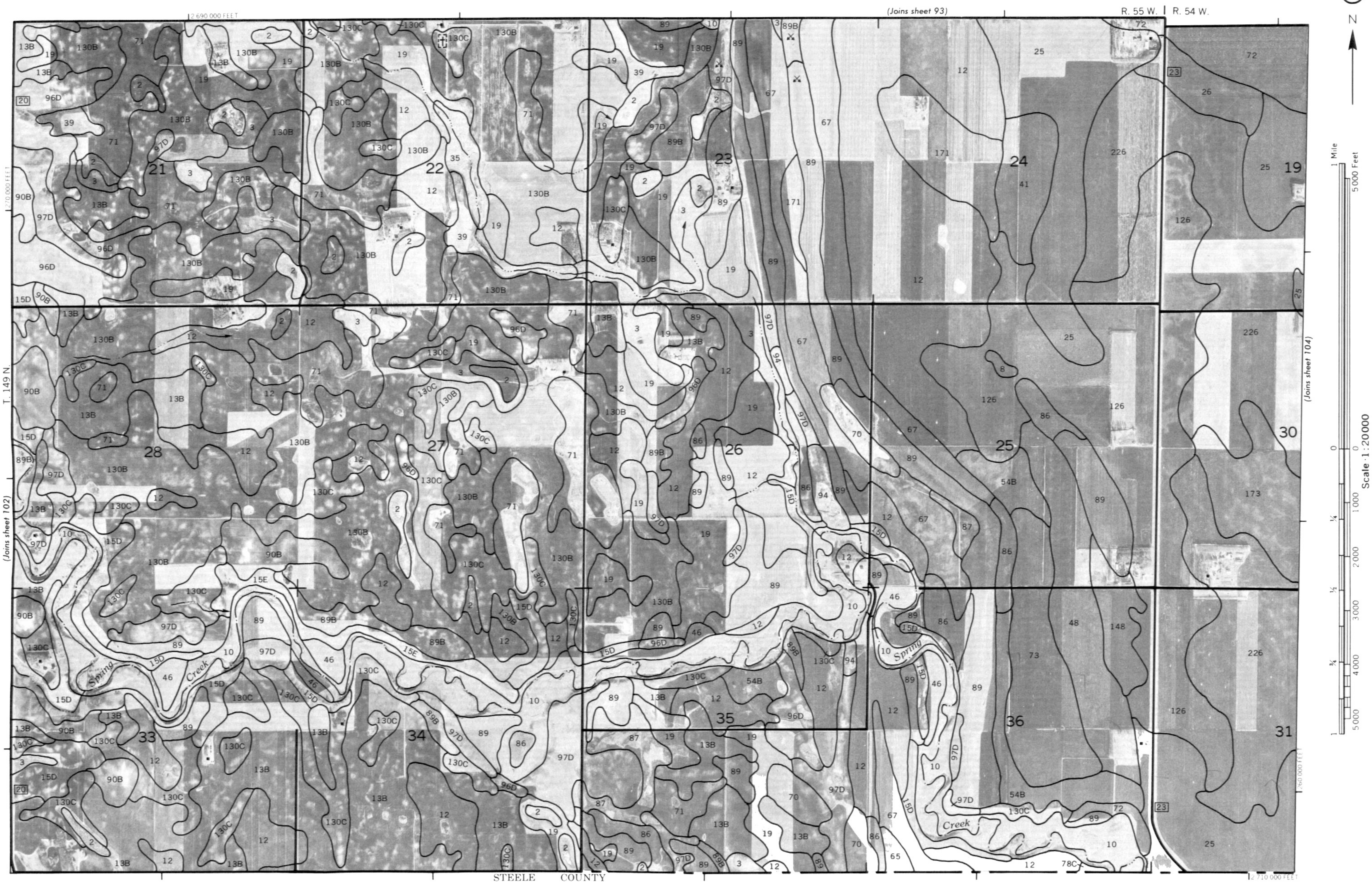
1 Mile

5000 Feet

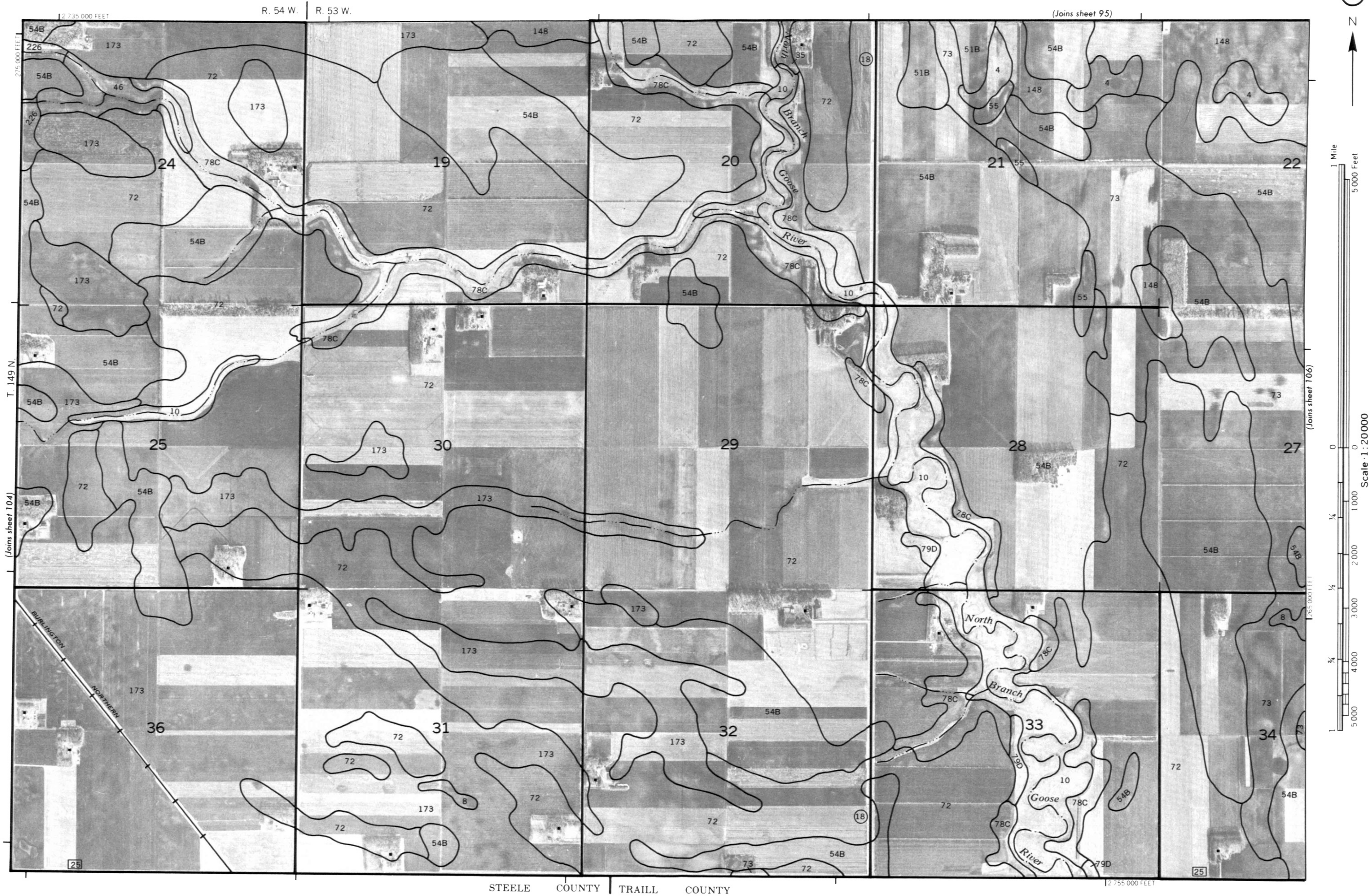

100
N
(Joins sheet 90)
(Joins sheet 99)
(Joins sheet 110)
(Joins inset, sheet 80)
R. 50 W.
R. 49 W.
T. 149 N.
Scale 1:20000
1 Mile
5000 Feet
2 875 000 FEET
2 855 000 FEET
Cole Creek
DRAIN NO. 10
RED RIVER
POLK CO.
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
73
79B
79C
79D
126
226
270
8
25
26
43E

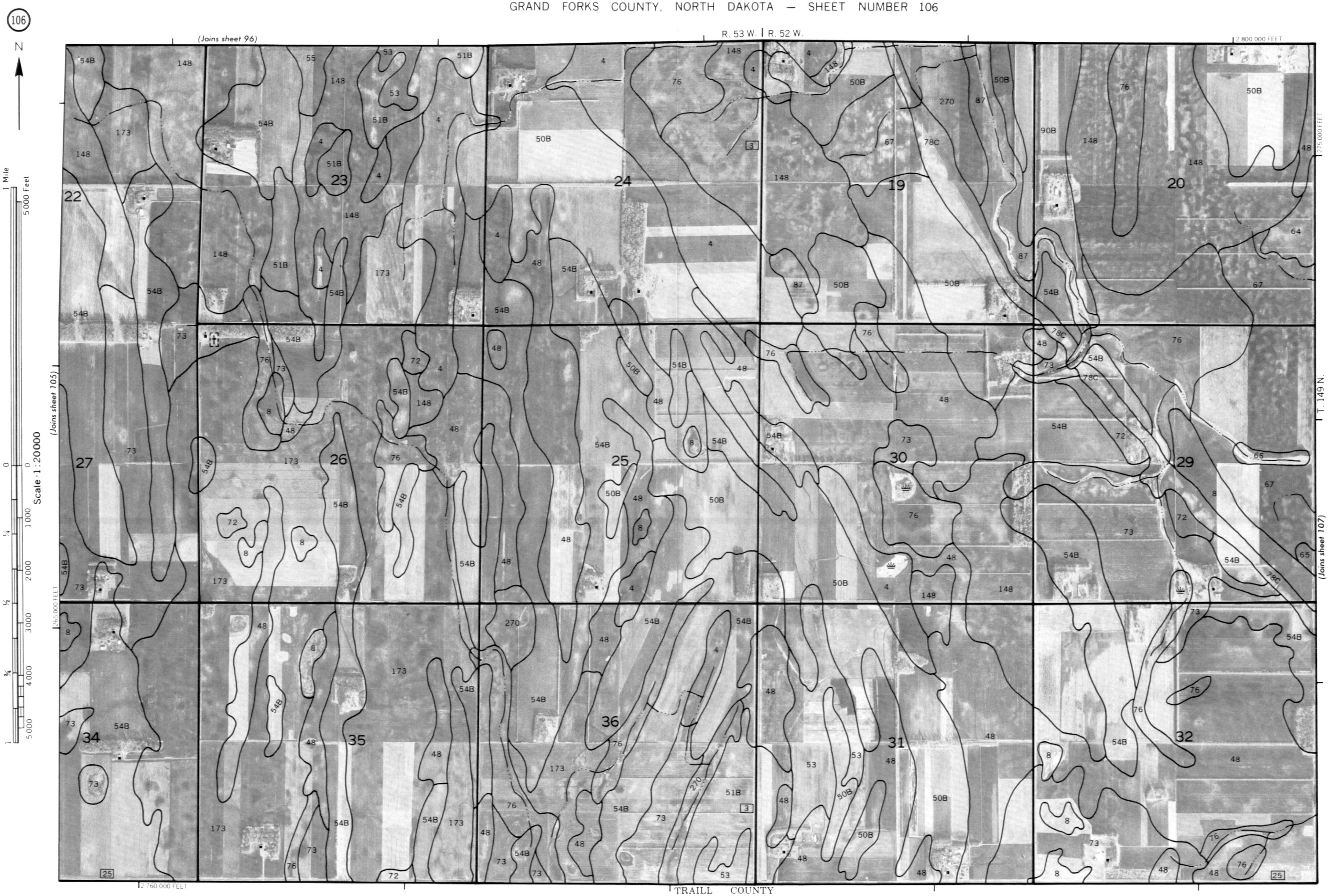

101
R. 56 W.
(Joins sheet 91)
(Joins sheet 102)
T. 149 N.
2 640 000 FEET
2 660 000 FEET
NELSON COUNTY
STEELE COUNTY
Beaver Creek
19
20
21
22
27
28
29
30
31
32
33
34
N
1 Mile
5000 Feet
Scale 1:20000

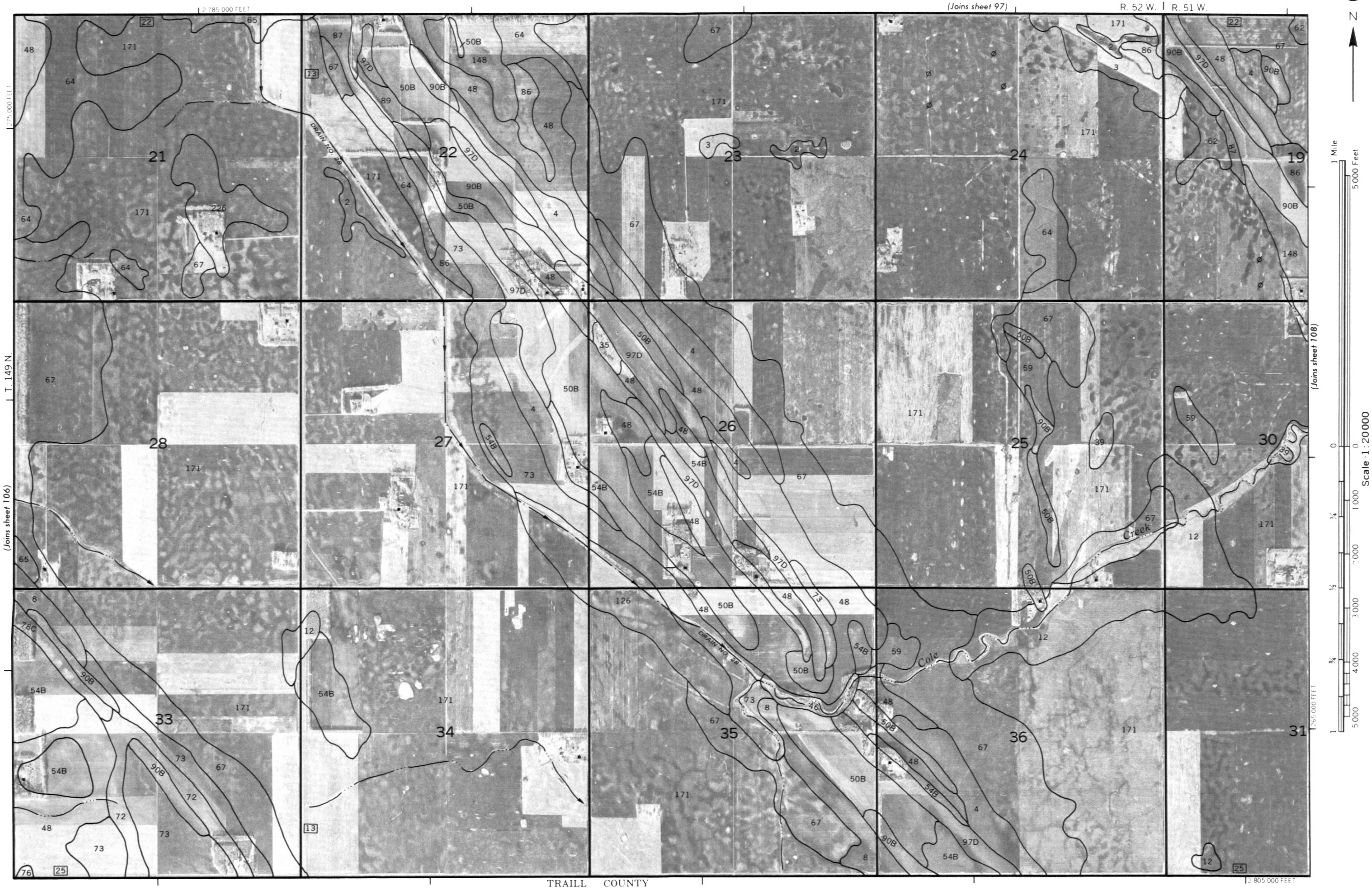

(Joins sheet 92)
R. 56 W.
R. 55 W.
2 685 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 101)
(Joins sheet 103)
T. 149 N.
Spring
Creek
water
STEELE COUNTY
2 665 000 FEET
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


103
N
(Joins sheet 93)
R. 55 W. | R. 54 W.
2 690 000 FEET
270 000 FEET
T. 149 N.
(Joins sheet 102)
(Joins sheet 104)
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
Spring Creek
STEELE COUNTY
2 710 000 FEET
260 000 FEET
1 Mile
5000 Feet
Scale 1:20000

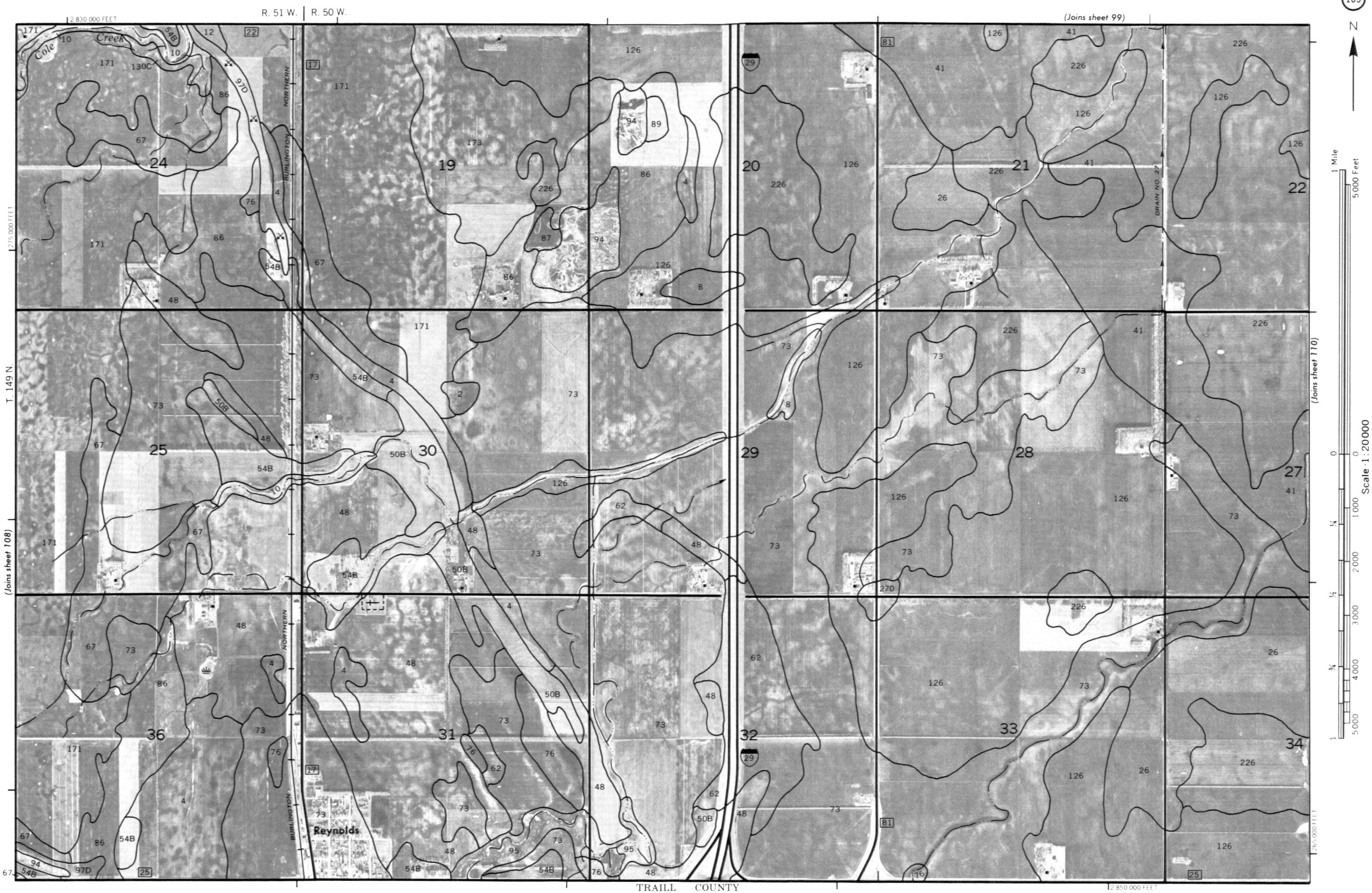
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 104


105
N
R. 54 W.
R. 53 W.
(Joins sheet 95)
T. 149 N.
(Joins sheet 104)
(Joins sheet 106)
2 735 000 FEET
275 000 FEET
255 000 FEET
2 755 000 FEET
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
North Branch Goose River
North Branch
Goose River
BURLINGTON NORTHERN
18
25
STEELE COUNTY
TRAILL COUNTY
1 Mile
5000 Feet
Scale 1:20 000
0
1000
2000
3000
4000
5000
¼
½
¾
54B
173
72
78C
10
148
51B
73
4
55
35
79D
8
46
226

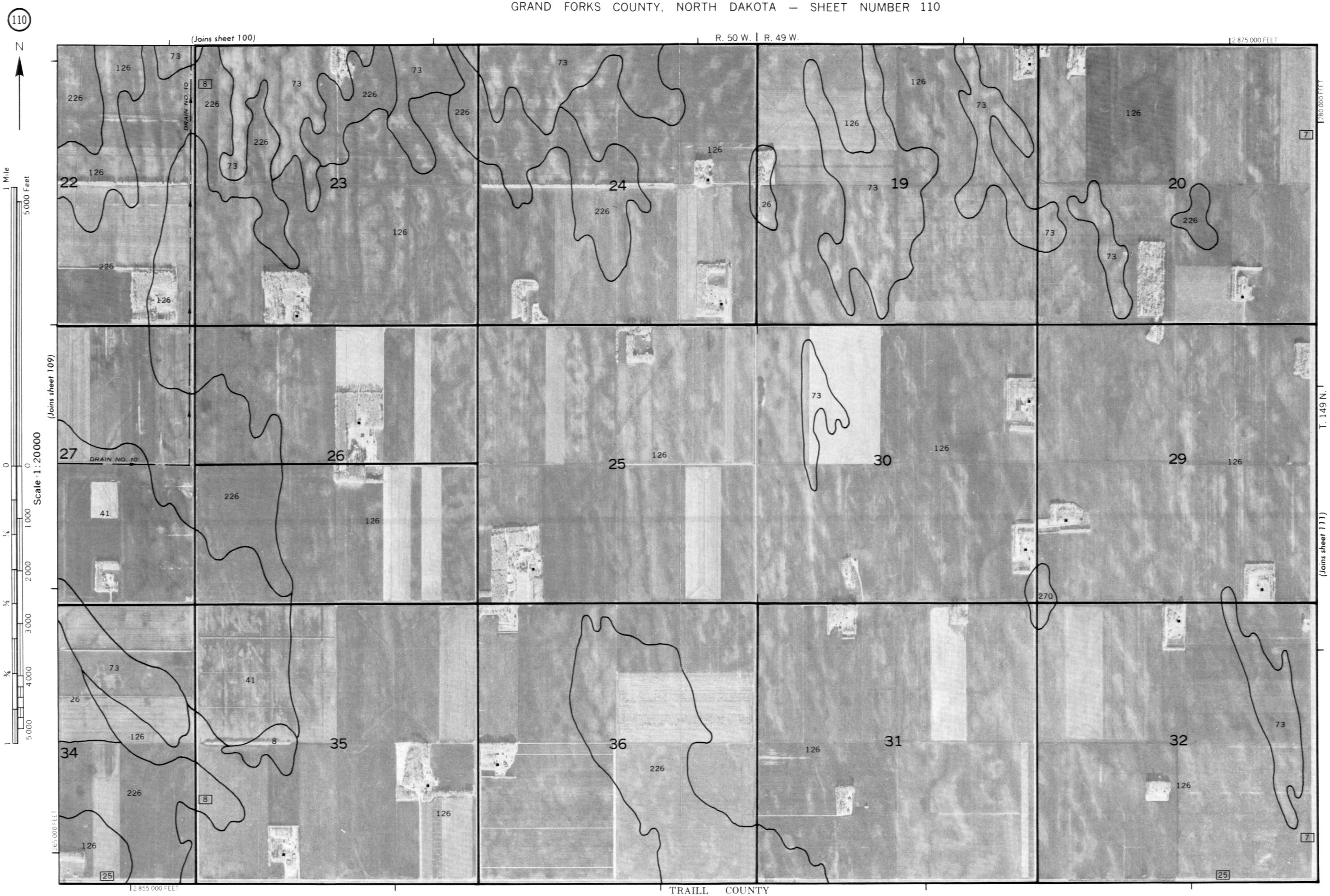

106
N
(Joins sheet 96)
R. 53 W. | R. 52 W.
2 800 000 FEET
275 000 FEET
T. 149 N.
(Joins sheet 105)
(Joins sheet 107)
265 000 FEET
2 760 000 FEET
TRAILL COUNTY
1 Mile
5000 Feet
Scale 1:20000
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


107
N
2 785 000 FEET
(Joins sheet 97)
R. 52 W.
R. 51 W.
275 000 FEET
T. 149 N.
(Joins sheet 106)
(Joins sheet 108)
1 Mile
5000 Feet
Scale 1:20000
DRAIN NO. 28
Cole Creek
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
765 000 FEET
TRAILL COUNTY
2 805 000 FEET


108
N
(Joins sheet 98)
R. 51 W.
2 825 000 FEET
T. 149 N.
(Joins sheet 107)
(Joins sheet 109)
TRAILL COUNTY
2 810 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
DRAIN NO. 33
Cole Creek
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
22
5
25
171
67
48
50B
12
64
97D
90B
54B
4
2
86
87
60
62
148
46
59
39
3
10
53
76
94


R. 51 W.
R. 50 W.
2 830 000 FEET
(Joins sheet 99)
(Joins sheet 108)
(Joins sheet 110)
T. 149 N.
275 000 FEET
265 000 FEET
2 850 000 FEET
TRAILL COUNTY
Cole Creek
NORTHERN
BURLINGTON
DRAIN NO. 27
Reynolds
N
1 Mile
5000 Feet
Scale 1:20000

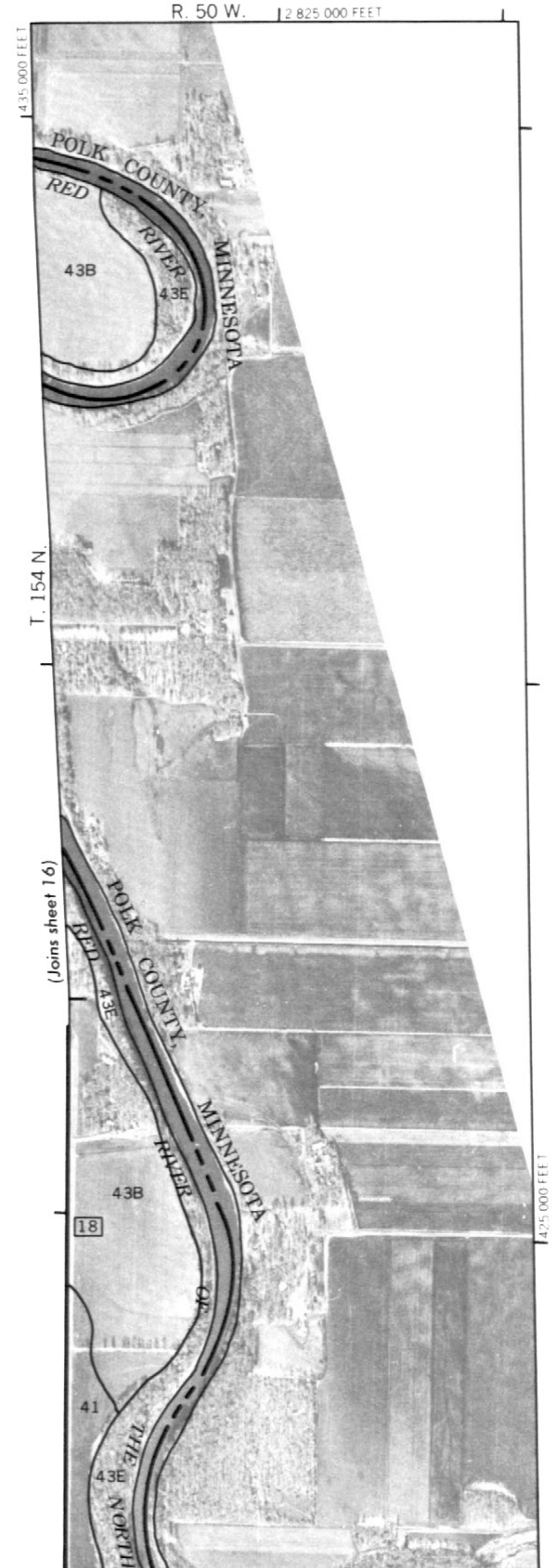
GRAND FORKS COUNTY, NORTH DAKOTA — SHEET NUMBER 110



N

(Joins inset, sheet 80)

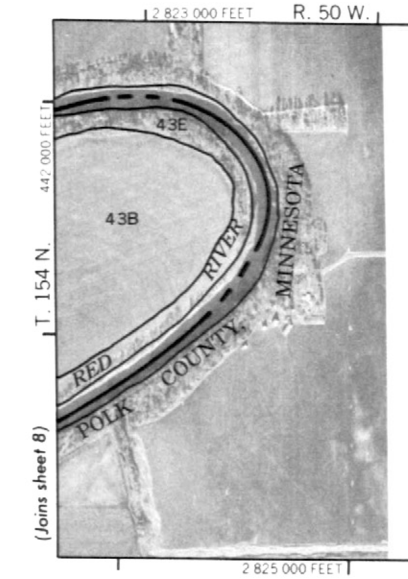
INSET B



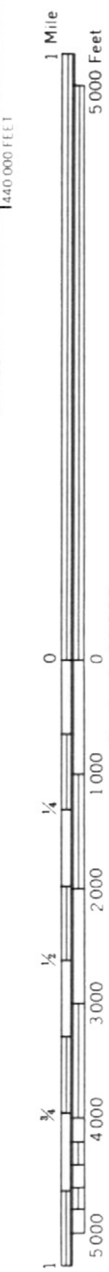
(Joins sheet 25)

2000 AND 5000-FOOT GRID TICKS

INSET A



2000-FOOT GRID TICKS



Scale 1:20000